ANNUAL MEETING
HOTEL STATLER, BOSTON, MASS.
SEPTEMBER 28th & 29th, 1943

Volume 57 | June, 1943 | $4.00 a Year
Number 2 | Page 79-171 | $1.25 a Number

JOURNAL

OF THE

New England Water Works Association

ISSUED QUARTERLY

Published by
THE NEW ENGLAND WATER WORKS ASSOCIATION
613 Statler Building, Boston, Mass.

Entered as second-class matter September 23, 1903, at the Post Office at Boston, Mass., under Act of Congress of March 3, 1879
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THE Association was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 800 men. Its membership is divided into six classes, viz.:

A Member shall be an officer or employee of a public or private water works, an engineer, chemist or other person qualified to aid or interested in the advancement of knowledge relative to water works.

An Honorary Member shall be a person of acknowledged eminence in some branch of water supply or of engineering.

A Junior shall be not less than eighteen years nor more than twenty-five years of age, a student or connected with water supply work.

An Associate shall be either a person, firm or corporation engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works.

A Corporate Member shall be either a Water Board, Commission, Company or Municipal Corporation.

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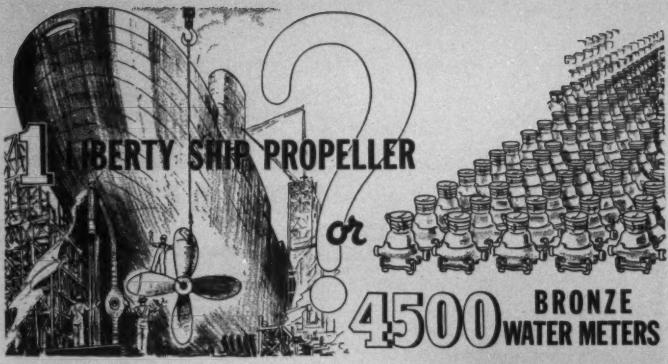

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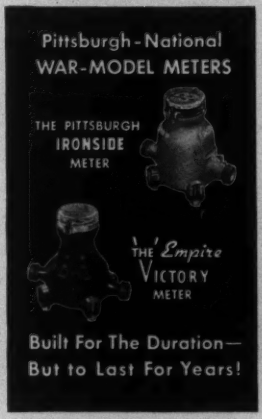

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AIR RAID PRECAUTIONS SCHOOL FOR WATER WORKS INSTRUCTION

of the

NEW ENGLAND WATER WORKS ASSOCIATION

and the

OFFICE OF CIVILIAN DEFENSE

January 20 and 21, 1943

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New England Water Works Association
ORGANIZED 1882

VOL. LVII June, 1943 No. 2

This Association, as a body, is not responsible for the statements or opinions of any of its members

OBJECTIVES OF THE SCHOOL

BY HOWARD H. POTTER*

I do not believe that it is necessary to go into an extended discourse on the objectives of the school, but it seems to me that a few words will clarify how the school came to be held and how it happens to take its present form. That may enable you to have a somewhat clearer understanding of what we are trying to get at.

The Executive Committee of the New England Water Works Association last winter held a meeting at which I happened to be present, on another matter, and during the course of that meeting they brought up the subject of having a two- or three-day school for water works instructors; in other words, a course to teach water works men how to go back into their own localities and teach, rather than giving the operators material on the subjects that they were intended to teach. There was some discussion of the length of the school and its being given in a continuous session or in parts at each monthly meeting. The Committee decided that if water works men were going to need the information at all they were going to need it before the end of the winter. Hence it was decided to hold the school all at one time, at the time of the January meeting of the Association. They then turned to me, asked me what I thought of it, and enquired if the Office of Civilian Defense would be interested in collaborating in preparing the program for the school. Subsequently I arranged for a meeting of the "school committee" with Mr. Loughlin, the Regional Director of the OCD, at which were present various members of the staff, and following that meeting, from notes taken as to what seemed to be desirable courses to introduce, the program was mapped out much as it appears on the following pages.

The question as to why the Office of Civilian Defense should be connected with this school is probably in your minds. I am sure that you have felt, to a greater or less extent, that the water works field has

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not been considered by the Office of Civilian Defense to an extent commensurate with its importance. However, OCD is becoming increasingly aware of this fact and especially so in this First Region. Perhaps it might be well to say, therefore, that this is the first of what I hope will be many occasions, as opportunity permits, for the Office of Civilian Defense to make up that deficiency and to try to collaborate in every way possible with the water works profession to assist them in their problems and to give them all the information at its command.

This program will be given by consultants to the OCD who are at the service of the Regional Office, and they will try to tell you what you may expect as a result of enemy action. I hope that every one of you will feel that he has derived benefit from attendance at the School.

ADDRESS BY JOSEPH M. LOUGHLIN*

Mr. Chairman and members of the New England Water Works Association: It is a pleasure to be here. When I was going over in my mind the things that I wanted to say, I did the natural thing and thought at some length of talking to you on the question of water supply; but as I thought the thing through, I knew that you knew better than I that no community could sustain life or continue to exist against an invading army without an adequate water supply. I knew that you knew that this had been demonstrated time and time again ever since history has been recorded. It was true twenty-five hundred years ago, it was true of the ancients, it was true when the Japanese took Hongkong and Singapore. It might well be true again on these American shores if enemy bombers attacked some community where proper planning and proper foresight had not been given to measures to provide an adequate water supply to protect the population against what is our greatest hazard today: fire. All these things you know, and, as I have said, you know them better than I.

You know also the steps that you have taken, both before this war began and since, to protect the public and to safeguard them in the work which is your responsibility. You know the efforts that you have made in your several municipalities as an association to cooperate with the civilian defense officials, both on the local and state and regional levels; and I want to say here that these things we fully appreciate.

Because you know these things, it seemed to me that it would be better for me to do the unexpected and to talk to you, not about the subject of water supply but to tell you something of a phase of civilian defense with which you may not be quite so familiar and which, therefore, you may find interesting. I would like to tell you today something about civilian defense in New England, its past, and what we hope for it in the future.

During the year 1942 we in civilian defense in New England—by that I mean those people on the local level and the state level as well as at the regional level—brought about tremendous accomplishments,

*Regional Director, First Civilian Defense Region, Office of Civilian Defense.

although we carried on our work under rather extraordinary difficulties. We had the job during 1942 of organizing various services and divisions from Eastport, Me., to Greenwich, Conn., and from the Atlantic Ocean to the New York State border line. We had the job during 1942 of overcoming apathy, of overcoming that attitude that was so prevalent shortly before Pearl Harbor, that "It can't happen here," that America is 3000 miles from Europe and no such thing as has happened in Europe can happen here. We had the job of conducting an educational and training campaign for the largest volunteer organization that was ever assembled in these New England States or in the United States. It took a lot of argument on the part of the people interested in civilian defense to convince a great many other people that they could not rely on some unexplainable, God-given characteristic that insured us Americans against the sort of fate that befell Poland and France, and Norway and Holland, and the other invaded countries of Europe because they were unprepared.

I repeat that I think we have accomplished much in making our people home-defense conscious. Today the person who doubts the need of planning or training for protection on the home front is definitely in the minority. Events during the past year have shown beyond any shadow of a doubt that disaster can overtake us, and that at any time. Disaster does not wait, necessarily, for the impact of the enemy's incendiary bombs or his high explosive bombs or block busters. Disaster lurks everywhere, and during the year 1942 in these New England States we have been visited by disasters, some of local or minor importance and others of major importance. But in each instance where there has been disaster, civilian defense forces have given a good account of themselves. Civilian defense has proved that the training and the exercises and the practice in which the organization has engaged have not been wasted time, because in each of these disasters civilian defense organizations have had a part in assisting regular municipal and state officials to relieve suffering and to save life and property.

I think we have definitely demonstrated during 1942 that civilian defense as an organization is not just playing, is not something that is a plaything for a number of people who happen to be interested, but that it is something that is worthwhile and something that is necessary during this emergency.

Let me point out a few examples to you. Less than two months ago, almost in the shadow of this building there occurred a disaster that rocked the United States of America and gave pause for thought to the peoples of the other United Nations. I refer, of course, to the Cocoanut Grove disaster, which took approximately 490 lives. That night at Cocoanut Grove there was a capacity crowd. It was the night after a very popular and important football game which is played in this city each fall. Approximately at 10.15 there was a flash of fire, and the results were tremendous in a very short period of time. The results of that fire were similar to the results that might be expected from a direct bomb hit. As word spread about the community of the Cocoanut Grove disaster, civilian defense volunteers mobilized, reported to the scene of the disaster, and worked shoulder to shoulder with the regular firemen, policemen, and members of the Army and Navy in helping to remove victims from the building, in assisting in the direction of traffic, in transporting the injured to hospitals, and in giving first aid assistance on the spot, where they could do so. Within fifteen minutes after that fire had started the first victims began to arrive at hospitals in the city of Boston and in surrounding towns, and the hospitals did a magnificent job. They were able to do an outstanding piece of work because they were organized under the civilian defense program for emergencies similar to the Cocoanut Grove disaster. They had practiced and they had organized to be ready for any kind of catastrophe that could be visited upon us. They were able in the hospitals to give quick and efficient aid to those who had suffered at the fire.

And again thanks to civilian defense planning, blood plasma in sufficient quantity was available for the use of those victims. The use of plasma after that fire was greater than it had ever been in any single place in the world up until that time. The use of plasma at the time of that fire was, in my opinion, a medical milestone, and there is no doubt that it was the means of saving many lives. I might digress to say that we had readily available in hospitals and in our own office on the night of that fire, just within Greater Boston, something like 2500 units of blood plasma, and we had within New England up to 10,000 or 15,000 additional units.

Immediately after the fire nurses and doctors in the hospitals

worked hour after hour to the point of exhaustion, and working alongside them were civilian defense nurses' aides. It is to the everlasting glory of these women, who serve without compensation, that they took every job that was handed to them, and did many things that relieved regular doctors and professional nurses so that they could perform more important missions in the interest of those who had suffered at the fire.

While the victims of the fire were being brought into the hospitals and into the morgues of this city, there was set up in the Civilian Defense Headquarters in the city of Boston a new device known as a Master Disaster File, which was simply a quickly assembled card catalogue of the persons who had been taken to hospitals as well as those who had died in the fire and who had been identified. The Civilian Defense group responsible for operating this File, swung into action, and within two or three hours after the fire the first list of the casualties and dead was turned over to the newspapers, and almost hourly after that, as there were changes in the lists revisions were given to the newspapers. By this method everybody might know whether or not somebody connected with him had been a victim of the fire.

The lists were the basis of the Army and Navy identification of service men who were victims of the fire. The organization of the Master Disaster File, although it was quick, continued for about a week, until a final and complete list had been checked and rechecked, and until the last person had been identified, so that the public might be informed from time to time as to who had been a victim and how many victims there were.

This Cocoanut Grove disaster was, to be sure, an outstanding example of what civilian defense forces can do. We have had, however, other similar instances during the year 1942, although they were on a much smaller scale. In the spring of last year, in Provincetown, Mass., the civilian defense force turned out to give aid and assistance to the victims of a sea disaster off the Cape.

Deep in New Hampshire is the little town of Fitzwilliam. It is a town that has no claim as a military objective. It is a town that is not classed as a manufacturing center. It is a town that cannot be said to be in a strategic area. One might wonder why a town like Fitzwilliam would have a civilian defense force at all. But Fitzwilliam did

have a civilian defense force, and that civilian defense force served its purpose and proved that it was worthwhile about the middle of last summer. There was a washout on a railroad just north of the town of Fitzwilliam. A train ran into that washout, cars were derailed, and a number of the passengers on the train were injured. One of them was able to crawl out and get to a telephone, and he called the local Control Center at Fitzwilliam. Immediately the civilian defense forces organized and went out to the scene of the wreck. They quickly improvised a couple of ambulances out of beachwagons. What few auxiliary police they had took up their stations to keep the roads clear, and that organization went to the scene of the wreck and assisted in removing the victims, giving them such first aid as they were able to on the scene and then removing them to hospitals.

The following day an army bomber crashed into a mountainside in the vicinity of Peru, Mass., up in the Berkshires. Peru cannot be said to be a target area, it cannot be said to be in a strategic area, yet Peru had a good civilian defense organization, and it seems to be a tradition in Peru that every man, woman and child in the town must be an airplane spotter. As the people around in the community heard the roaring of airplane engines and suddenly the crash, a report went back to the Peru Control Center, and the organization of that small town was quickly gathered together and went out in search of the plane. The trip to where the plane had crashed was rough and hazardous, but the natives knew the vicinity and knew the land round about, and they got in there in the quickest possible time. There were a number of men in the bomber. Some of them were dead, but there were three men alive, and the civilian defense force of Peru saw to it that those men were given first aid and carried down through the rocky, rough, wooded terrain to the highway, placed in improvised ambulances, and removed to hospitals. Those men owe their lives to the work done by the civilian defense forces of Peru, Mass.

In the past year, there have been fires of various sizes in numerous communities throughout New England in which civilian defense forces, particularly auxiliary firemen, have given a good account of themselves in saving life and property. I refer you only to a couple; one at Pennacook, N. H., during the early winter, and another one at Stafford Springs, Conn., within the last few weeks.

There are numerous other instances where civilian defense forces have aided the local authorities in locating children who have been lost, and where they have assisted people who have been injured, giving them first aid and doing a real job as an organization. In other words, we have numerous instances where civilian defense forces have put into practice the things they have learned in their civilian defense training.

During the recent ice storms that visited the western part of Massachusetts and parts of Connecticut, when telephone lines went out I saw the community civilian defense forces set up courier service to be sure that communication with outside communities was maintained during the emergency period.

We feel that these accomplishments that I have enumerated, and many more, were possible because of the drills, exercises, and training that have prepared workers to be ready for emergencies. In the past, we have had frequent practices and drills. In the future, we plan many, many more of them, because only by keeping our organization trained and alert can we hope to be ready for action when action is needed.

In civilian defense we have a large overturn in our personnel, due primarily to illness and to loss of men and, now, women to the armed forces and to the war plants. This turnover is another reason why we feel that it is important to have frequent drills and exercises and repeated training courses.

The longer the enemy delays in attacking us from the air, the stronger the impression is likely to grow in this country, as it did in England in the early days of the war, that the attack will never come, that it is a "phony war" so far as we are concerned. Maybe the attack won't come. I hope sincerely that it never will. But I also hope equally sincerely that it won't come, if it does come, at a time when the people of this country or the people of New England have decided that protective measures are just a waste of time. If the time should come when the people in this country generally feel that organization and planning for protection on the home front are not worthwhile, that is the time at which the enemy is most likely to strike.

Modern war is a complicated and ever changing job which presents ever changing conditions that make the job of training on the home front involved and complicated. Let me give you an example of what I mean. During the past year, we have had three different

methods for combating fire bombs, due primarily to the change of technique that the enemy has used. We first trained a million people or more to combat fire bombs with a spray from a hose or stirrup pump. After that, because of change in bombing technique and bomb construction, we had to go back and say: "Don't use the spray, the solid stream is the way to combat this type of bomb." If you think that it is a small job to teach a million or a million and a half people to use one technique, and then tell them to change because of changing conditions, you have another guess coming, because you not only have to retrain them but also have to convince them that the change is necessary in times such as these.

Then during the latter part of 1942 we had to ask people to change their technique in training for the handling of incendiary bombs a third time, because at that time the enemy decided that he not only wanted to use magnesium and thermite in his bomb but that he also wanted to put a shot of TNT in it so that it would explode. Obviously the method of handling a bomb that has a high explosive in it as well as thermite and magnesium is quite different from the combating of a simple magnesium and thermite bomb.

We have had these changes and we have had others, and I say to you that we may expect more during 1943. As we push the enemy harder, we may expect those changes to come with greater frequency. I urge upon you, therefore, to keep your mind open to these changes, to accept them when they come to you, and to do what you can to get them across to those people with whom you come in contact. They are handed down to us from the best authorities that we have in this country. All of these things are a part of our job. I tell you about them not to complain but to point out that ours is not a simple job.

In Civilian Defense we have other responsibilities besides the job of protection, and these other things become more and more important as the war goes on. I refer to such things as assisting the OPA in the job of mileage rationing (gasoline rationing), in helping to educate one another in the need of food conservation, in assisting in getting in the scrap, and myriads of other projects that are not of a protective nature.

Between the protection aspects of the civilian defense program and the nonprotection aspects, or the civilian war services as the nonprotective program is called, I would estimate that in the year 1942

approximately half of the population of New England played some part in civilian defense, but it seems to me that during 1943 we have to do considerably more than that; and I hope that by mid 1943 we can say that everyone on the home front in New England is taking his part in civilian defense in one way or another.

The way we propose to accomplish the job that must be done in civilian war services—because they are important to victory—is by way of something we call a neighborhood plan or block plan. It is an old idea; it is not new. It is an old idea with a new name. It is the old New England community spirit brought back to life again. It is neighbor help neighbor. It is all for one and one for all, and we must have it. We must have complete cooperation, complete unification, if we hope to achieve victory against oppression.

ORGANIZATION OF CIVILIAN DEFENSE

BY DUDLEY A. REEKIE*

Some of my introductory remarks are not going to be news to you. I believe, however, that it is worthwhile mentioning them if for no other purpose than to show how civilian defense became necessary and why civilian defense was organized.

In other wars the opposing armies fought each other at practically fixed lines. Mobility, yes, between the tactical forces, but the civilian populations by and large were not affected by the implements that those armies were using. In Spain we began to learn what mobile equipment could do to civilian populations. We saw and learned what England went through in 1941. Therefore, it became recognized by our military people that, while an army has both offensive tactics and defensive tactics, I mean military defense, it was necessary to organize a civilian defense system that is in a large measure parallel to and quite similar to military defense. That is what was developed in the Spanish war, and we were to learn more about it from the British plans and by reference to the British publications of 1938-40. When you add to that the experience Britain had in 1941 and 1942, we see that plan then worked out for what we might sum up as disaster relief for civilians who are receiving the attacking end of the mobile military weapons. Therefore, General Grant was assigned by the War Department to the Office of Civilian Defense to develop the protective services of civilian defense.

Civilian defense as we organized it in this country includes two branches, the Protective Service and the Civilian War Service. I shall talk briefly about the Civilian War Service first, for I want to talk at length about the Protective Service.

Civilian War Service is the branch of civilian defense that is designed to interpret to our citizens national problems in which there is required national participation, such as scrap collection, the interpretation of rationing policy and procedure, the interpretation to the public

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of certain nutritional information, information about why and how they should share our meat reserves, and so on, through what we call a block system. This is a method of piping out information to family groups of people as they live in blocks and in sectors of a town.

The Civilian War Service branch is also the branch of civilian defense which accumulates information about the names, addresses, and the abilities or skills of different people and classifies all volunteer workers. They are classified in this roster of information and from here selected for assignments to the protective services. I believe that is enough to say about the Civilian War Service here, but it is important to distinguish the two branches.

The protective side of civilian defense is designed to select and train volunteers, and to turn them over to the functioning heads of the protection units of this Protection Branch. In peace-times the city fire department, police department, the medical and hospital assets of a community, in most cases can absorb the shock of quite a large disaster. In great disasters these departments or services have to call for mutual aid. That is well enough in peace time, and prearranged mutual aid is possible when we are facing a single disaster. The protective service of civilian defense is set up for multiple disaster. Community A might have an enemy attack with considerable damage, and there is no use relying on aid from community B, which may be having the same sort of thing or even worse, so that the community reinforcement has to be planned in a more specific way to meet the effect of enemy attack.

Therefore, the protective organization was worked out first of all to assign and post out civilian ears and eyes, according to a plotted system, to listen for enemy bombers. Those aircraft warning people funnel that information up to the filter centers, and from the filter centers it goes to the information centers, and when a pattern is established at the information center by so many reports coming in from a given area that there is no doubt of error, and when it is established that attacking planes are enemy planes, the plan then is to alert the civilian defense organization from the information centers, which are operated by the army.

In the protective service we have as the keystone the warden. He is the man who takes his assigned place on a given signal; he is the

person who is responsible for knowing where people live, what shelters they are using, who is in what shelter, and who is not in a shelter; and he reports all damage when an attack occurs.

Now that reports of British experience are available, we are more and more wishing to adapt some of the British experience in our planning, for instance, referring the fire information to the fire department. At the present time the fire department is in the control or report center. When information comes into the report center it is turned over to those whose function it is to meet and act in the emergency, such as the police or the field casualty service.

In Britain most of the damage by the enemy was damage by fire. Eighty per cent of the damage by enemy planes was due to fire. Fire has to be controlled. The fire department has a rescue service to rescue people from burning buildings.

If we are planning against air raids, we have got to use a little more imagination as to what high explosive bombs mean. Consider a row of apartment houses or apartment buildings with two or more floors, and reflect on what is in those structures. There are heavy bathtubs, heavy refrigerators, and heavy stoves. Try turning your nine cubic foot refrigerator around. There is heavy furniture, quite frequently pianos. A shattering bomb will spring the buildings apart and the whole works will go down, down, down. Furnishings will all crash through to that bottom floor, either breaking it in the middle or knocking it loose at one end. If people are in good strong shelters, all well and good, but with all the rubble piling down, there is a very real rescue job to do in getting trapped people out. If water mains are broken, they may be drowned before you get them out. There is a tunneling job, a job of rescue, and we must have people who understand building construction, the principles of levers, and all that sort of thing, who can assess the problems, sink shafts, tunnel in, go through foundation walls, and if that is not possible, do a mining and shoring job in the rubble in order to get in there and rescue people. These Rescue Squads should at all times be working in coordination with the other forces in the community.

The police departments have a real job to do. Many people are inclined to talk about panic. Some are inclined to talk a lot about panic. Personally, I know of no better panic control than to have people

busy with a job to do. You never saw children start a panic. You never saw women responsible for children start a panic. Panics are usually started by men. It is no use kidding ourselves, panic is a problem. It has been a problem at times in Britain. When the attack on Glasgow came, many people just took off, wandering, glassy-eyed into the streets and out into the country. A lot of the civilian protection personnel disappeared until they came to their senses later—a day or two later.

The censors have not passed much information about panic problems in Britain, but we know of those panic problems and that panic prevention is a very real problem. I mention it to show you the job the wardens, under the police, have to do.

The police department will be responsible for auxiliary policemen and can probably provide much of the communication facilities for warden reporting. In Britain all warden reporting is focused up through the police system. The Medical Division in the Protective Service is responsible for all functions that affect the lives of human beings—injured human beings. That is why the Medical Division has had assigned to it by General Grant a Gas Defense Section, and there is going to be in the very near future a section on rescue—rescue of the kind I described a minute ago and not to replace the rescue functions of the fire department.

I am quite frank to say that in various communities city departments have felt that the local organization for civilian defense was in a way an upstart organization, an organization that was just taking over the functions, the established and legal functions of these city departments. This is unfortunate. A civilian defense organization in a community, if it is going to be worthwhile and if it is going to be successful, must include as the key people the heads of the departments of police, fire, and so on. Obviously, the normal facilities of fire and police departments in the community must be expanded with auxiliary helpers, and it is the responsibility of those departments to take volunteers and train them so that when they need auxiliary help, when they need to augment their departments, they will have dependable help. We must give up any idea that we can turn to the next community and expect help, because if we are going to have enemy attacks there is no one town that is going to get it, but several towns will be involved, and

Town A, as I said before, will not know what is going on in Town B, and Town B will not know what is going on in Town A. We must be resourceful in our own community. Of course, if local assets are wasted or exhausted, or insufficient to meet the problem, we have the right to call for mutual aid, and by reversing the funneling out system of warnings, going back up through the communications system, you can go to headquarters, whether they be county, regional, or district, even back up to the State level, and mutual aid will be found for you through that level.

It is important in attack by the enemy that all Control communication and all the operations of the Protective Services in civilian defense be of a similar character and be channeled through proper sources. There are a number of communities that have mutual aid disaster plans. Electric light companies know where they can go to get mutual assistance in case of trouble, and water departments obviously know where they can secure mutual aid, material, and pipes. But again, whatever your plant is, you should dedicate the property and facilities while the war lasts, to your local civilian defense council to care for any disasters that might result from enemy action. It is your responsibility to see that it is available to calls from the local Control Center.

I have recognized that many of you see a very real need for official recognition of your function in the local civilian defense setup and that you are a little worried; you are not sure that the people at that defense council level realize how necessary is your contribution.

Major Potter and I were discussing your problem the other day, and Major Brewster and I talked about this shortly after I came to this Region; a problem that we felt had very real merit. And that was, the impermeable paper bags with an absorbent lining for use in homes when the water supply may be shut off. Now, a lot of people are inclined to snicker at the idea, but I have been a health officer long enough to know what happens when a water supply is shut off.

I hope to see someone work out a plan by which we could somehow use the civilian war service group to so inform the public that there would be created a demand by people to buy a half dozen or a dozen of these bags and have them handy for an emergency. As a parallel to that, to find some merchant or merchants in the community

to stock these bags, we should dovetail the program to equalize the demand and the supply; they should be coordinated somehow. Disrupted sewage disposal becomes immediately a very grave problem from both the esthetic point of view and the health point of view.

We must not be content with wishing that we were in the local defense council. It is all right for us to go to the State defense councils, but we in the Regional Office can't reach all the local defense councils. You must try to create this demand and develop an understanding of your function at your level and that they will insist that you belong. You fellows have to push up these problems with the right kind of justification and statement of what you can do with your services for those local communities. Major Potter can get around to just so many places; the State Water Coordinators can get around to some more places. But here are scores of men who live water control, who study water control, whose experience and work is water control.

The doctor down at the General Electric plant in Lynn, when he considered the Cocoanut Grove fire, where people were caught like rats in a trap, got to asking himself, "What am I going to do if I get that many casualties all of a sudden; what is there in my community that I can get to help me? We have a medical department and we have some first aid equipment; we have a certain setup so that we could probably handle a dozen or more casualties, but I am absolutely out of my depth with five hundred casualties and I would have to depend on the community organization and resources, and what are those community resources?" His community has a very definite responsibility and it can't let that man down.

You are responsible men. You know what water problems are, and you ought to demand recognition of these problems by the community officials. You should worry about the setup, what will the city do in a disaster, just how far can it go by itself, and what auxiliary help has been trained. Do not rely on any previous mutual aid plans.

Just in passing, I will say that I was down in Maine the other day where they had included a water problem at Brunswick in the Command Post Exercise. Their answer was to ask for mutual aid.

General Eisenhower in Africa right now is wishing for civilian defense behind the lines. There is no dependable civilian defense organized in Algiers or in Casablanca or anywhere in North Africa,

and he wants it organized. As we occupy countries in this war, we must quickly look to an organization of civilian defense. I suppose they have civil defense in Germany, but it probably won't matter if we ever get in there.

We have come a long way in New England in the matter of terminology—the terminology that grew out of the plans that people developed in this region before other people were willing to even imagine that this country was going to go to war. We here had access to the British plans and to the reports of their experience in 1941-42, and we adopted those plans for New England. There grew up here a terminology that was quite appropriate to use in Britain, but as our national program of civilian defense got going, and as we sent observers over to Europe and people who had actually been on the firing line in Britain came over here to advise us, certain parts of that organizational structure had to be modified. We have tried to pipe this out to you and to keep you informed of it, and your communities have made an excellent response in getting into line. It is very necessary that we get into line because, after all, we have only one U. S. Army and one U. S. Navy, and we can have only one U. S. Citizens Defense Corps. We have to be able to cooperate with each other, we have to have a terminology that we can all understand, whether we come from Connecticut or Maine or Massachusetts. We have to have a terminology that the Army understands, so that if the Army, with its defensive facilities, ever has the occasion to come to our assistance, it will know what our organization is.

We particularly intend in the organization of our Gas Defense Program, headed up at the State level by State Gas Consultants and at the local level by Senior Gas Officers, to use the technicians and the chemists, who are called Gas Reconnaissance Agents. While "gas identification officer" seemed a quite appropriate title, the Army expects us to use "gas reconnaissance agents," and the Army as a whole knows that that is what we are going to call them.

Moreover, day by day, you see the Army interested in and wanting to know about the progress we are making in our civilian defense program. As an illustration of this, the Army will not take, nor even wish to take, a hospital for Army purposes until it checks on it with civilian defense authority to determine its civilian need first. The Army looks

to stock these bags, we should dovetail the program to equalize the demand and the supply; they should be coordinated somehow. Disrupted sewage disposal becomes immediately a very grave problem from both the esthetic point of view and the health point of view.

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to General Grant at the national level to state the policy and program; at the Regional level for us to work as consultants with you at the State level; to work out at the local level the proper kind of action agency.

You might be interested to know that there has been approved a program for taking care of any member of the U. S. Civilian Defense Corps who is injured while on duty. "While on duty" is interpreted to mean drills or while taking training for assignment in the Citizens Defense Corps, and the Citizens Defense Corps is that composite group of people assigned to jobs in the protective service units. If any of these people, while training for an assignment or while they are drilling, are hurt, they are to be taken care of by the Federal government. They get all their medical, hospital, X-ray, or surgical expenses taken care of. They receive cash benefits when necessary. If a man has his legs broken and is in the hospital and his wife needs cash assistance—perhaps she has several children and she must have money to get by on—she can, through a bureau in Washington, receive cash benefits.

Those of you who are associated with local defense councils or who can influence local defense councils, I hope, can see the wisdom of having each member of these protective units certified as members in the U. S. Citizens Defense Corps. This is a member's evidence and authority, if he is injured, to be an applicant for this war civilian security protection.

We are going to have to stick strictly to training standards. There is a movement underway in some of our States and Regions that first aid instruction is a lot of grief, that one can't get volunteer people to take a course in first aid. We want them to take ten hours of instruction, at least to the point where we can tell them what not to do.

I can see where, when we started organizing the Citizens Defense Corps, somebody had to publish the bulletins that could be used to instruct the air raid wardens, to instruct the auxiliary firemen, to instruct other auxiliary groups. It took time to publish these. The Red Cross was already geared to teaching first aid, and they got started while you waited for the bulletin on the other training programs. Ten hours in first aid instruction at that time was just ten hours, but it did not warrant a Red Cross certificate; ten more hours and one could have a Red Cross certificate. And now there has grown up in the minds of people the belief that they have to take the twenty-hour Red Cross

course to qualify as members in the Citizens Defense Corps. It is the desire of the medical service that the protective personnel, other than the auxiliaries and the people assigned to assist the Citizens Defense Corps, give at least ten hours to first aid instruction. We can then look to them to stop hemorrhage, to treat shock, to put on bandages, and to transport patients. We wish that the Red Cross training could be had by every citizen in the country. It would be fine if everybody could devote the time to it. That would then make it possible for anybody to aid himself or a friend in his own home if he were accidentally hurt.

One interesting observation regarding the Cocoanut Grove fire is that the people who kept their heads and remembered their first aid instructions grabbed a towel and stuck it in water and put it over their faces. One fellow who was behind the bar stretched out on the floor and took it. He was burned from the back of his head to the heels of his feet; but he lived, he did not get any of the fumes or the hot air inhalation burns. He kept his head and got down on the floor as he had been told, no doubt, at some course in first aid. Others who put wet towels to their faces did not develop inhalation burns or lung damage. They got out alive. If there were no other value than this, it is reason enough why everybody should have the first aid course. But, as far as our Citizens Defense group, our protective group, is concerned, they must have basic first aid instruction. We know that in Britain every man on the Citizens Defense Corps or the Civilian Protective Service has to have first aid, and they have proof of how this requirement pays dividends.

At some hospital in the Midwest they had to amputate a leg on two people and an arm on another in the last month because of misapplied tourniquets. One leg was wired up with a piece of fence wire to stop a hemorrhage. In Britain they have kept a record of the one tourniquet that was applied to a disaster victim. They just do not apply tourniquets in Britain. Therefore, I emphasize again that we cannot do anything more in ten hours than to tell people what not to do, and when we have done that we have discharged a responsibility that is a very real one.

ELEMENTS OF TEACHING

BY LIEUTENANT ROBERT L. STARR*

I am putting myself on the spot by giving this talk on teaching. As I go along I will probably feel that each one of you is personally picking me to pieces in respect to my own style of teaching, as compared with the principles I am going to present to you.

Everyone, at some time or other, has given instruction to another in some form. But were you a good instructor? Most of us are not. It takes training to make a good instructor. You will realize that as I go on with this talk.

I have with me a military training film on Methods of Instruction as used in the Army today. You will see this film later. But, before you see the film, I want to give you some idea of just what is required in successful teaching. This will, I hope, enable you to gain a better understanding of the principles laid down in the film.

First, just what is teaching? It has been defined as the process of controlling, directing or managing the thinking of the student so that he will be able to do and understand the thing which you plan to teach him. If your teaching fails to attain that objective, then there is something wrong with either the instruction, the method of instruction, or the course of instruction. You will notice that I make no reference to any failing on the part of the student. For our purpose we will consider the students to be adults, capable of retaining properly presented facts.

In outlining any course of instruction, there are two vital factors to be considered. These are "How much shall be taught" and "How much time can be spent on the subject". These factors are especially important in the present days of emergency, when every effort is being bent toward turning out as many trained persons as possible.

First, we will consider the question "How much shall be taught". This might well be determined by breaking the subject down in the following manner:

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*Bomb Disposal Officer, First Service Command, Boston, Mass.

What you must know
What you should know
What is well to know
What is nice to know

Let us apply this breakdown to a subject and see just what facts we must teach to enable the student to do the job and understand what he is doing. For example, the Bomb Reconnaissance Agent, a subject on which you have seen a training film. This agent *must* know the signs or indications of a UXB and how to report the facts to the proper authorities. He *should* know how to identify the various bombs, and the safety and evacuation measures to take for each. In these two sections there is sufficient knowledge to enable him to do a good job. Continuing, it might be *well* for him to know the possible fuses used in bombs and their sensitivity to outside factors, such as vibration. This addition to his knowledge would enable him better to understand the reasons for the safety measures he already knows. It would be *nice* for him to know the various explosives used in bombs, and a general history of bombing. However, these last two divisions are not essential as he could do a satisfactory job without knowing these facts. They are merely "background", to give the student a more thorough knowledge and understanding of the task.

The instruction time limit will usually be found to limit the amount taught to the *Must* and *Should* items. Therefore, your time factor is determined by how long it will take to teach those items.

This automatically leads us to the method of instruction that will give the best results in the minimum of time. Any method must, for good results, present the subject in a logical sequence and in a form best suited to the subject. It cannot be expected that a man will learn to fire a rifle by hearing lectures on the subject. That subject would require a different method of instruction, such as the coach and pupil method you will see later in the film. The method of instruction must fit the subject to be taught and present it in the clearest form possible. I will not go into detail on the various methods of instruction—the film will do that for me and in a far better form.

All knowledge is gained through one or more of the physical senses. It has been found by experiment that the knowledge of the

average person has been obtained through the different senses approximately as follows:

Sight	85%
Hearing	10%
Touch	2%
Smell	1½%
Taste	1½%

It is obvious that these percentages would not hold good in the case of certain professions, such as music with its sense of touch, or cooking with its sense of taste, but it is just as evident that the lecture alone would not be nearly as effective as the lecture accompanied by something the student can see, such as a demonstration, models, training films, or film strips. Any method of instruction that brings into use more than one of the senses, especially sight and hearing, is going far toward the ultimate goal of a good method of instruction.

In addition to appealing to one or more of the senses, it has been found that instruction is more readily retained if important facts are emphasized, or repeated several times. This may be done in a number of ways: in the lecture itself, in films with or following the lecture, or as a review or summary. The important thing is repetition of those facts that you want to stick in the minds of the students.

Now, what about the instructor himself? He must be capable of directing or managing the thinking of his students, or the immediate objective of all teaching is lost. He can't just present a lot of facts and let it go at that. The facts must be coordinated into a whole, and the student must understand and be able to use each separate fact of that whole.

It has been said that a good instructor is born, not made. The lie has been given to this saying. Instructors can be made. The military services are proving that every day, training instructors in all subjects, and training good ones. However, it is essential in training an instructor, that the person being trained have or develop certain personal and professional qualifications.

Let's take up the personal qualifications. The first is experience in handling people. This can be gained in a number of ways. Any contact by which you have the opportunity to direct or influence other

people is experience in this line. The amount of experience gained from such contacts and the use made of it is up to the individual himself.

The second personal qualification is a well balanced personality. This need not be inherent—it can be acquired through practice and study. A definition of this which applies well to the instructor is: A man's personality is based on his treatment of four items: *Things, Ideas, Himself,* and *Other People.* Let's take up these items separately and see what is meant. First, *Things.* As an instructor can he handle chalk or a screwdriver well in making a demonstration, or does he drop one and use the other carelessly? Second, *Ideas.* Is he open minded about ideas? Will he accept ideas offered by the students and apply them to the lesson? Third, *Himself.* How does he treat himself? Does he go to excesses? Is he neat? Last, *Other People.* How does he treat other people? Is he always pleasant and ready to assist and answer questions? Does his bearing and manner command respect? All of these items contribute in making a well balanced personality such as the successful instructor needs.

In addition to the items I have just mentioned, the instructor must be pleasant but firm in dealing with students. He should be neat and dignified and have a keen interest in his subject. No worse instructor will be found than the one who has no liking for the subject he is teaching. He must be patient and sympathetic with the student's problems and able to put himself mentally in the position of the student. Last, but not least, his voice must be loud enough for all of a group to hear clearly, and he must be able to speak distinctly. Remember, every person does not have these qualities. Some people can never acquire them. But, in general, if you apply yourself to the task, you can develop a style that is suitable for an instructor. It takes practice.

Now, how about the professional qualifications I mentioned before? The first of these is: The instructor must have a complete knowledge of the subject to be taught and be enthusiastic about that subject. It is very embarrassing for an instructor who is not able to answer unexpected questions from the students. Complete knowledge of a subject is essential.

The second essential professional qualification is: The instructor

must be able to plan instruction and to put the plan into effect. He must have a knowledge of instructional methods and ability to choose the best method to suit a given subject.

To sum up all these qualifications, we can say that the instructor must learn to give instruction in the most efficient manner, that is, he must get his instruction across in the least possible time with the minimum expenditure of energy on the part of both student and teacher.

Now let's take a look at some of the so-called "tricks of the trade", actions or things that can be used to advantage by the instructor to keep the expenditure of energy at a minimum and to improve the instruction.

First of all: talking itself. Sentences should be short. If you find a sentence bogging down due to its length, put a period to it. Then start another sentence. Don't use highly technical terms unless you have previously explained them or the students already know their meaning. Use down to earth language. Don't talk over the heads of the students. It is surprising how many instructors fail to realize that it is hard for a student to grasp things when he doesn't understand the terms being used. Remember, as an instructor you are trying to present facts for the student to retain, you are not conducting a review of your own knowledge and trying to impress the student with the greatness of it.

Any lecture is of necessity tiresome to listen to. So, try to vary it as much as possible. Vary the rate of speech, but stay between 90 and 160 words a minute. Below 90, the words lag and instruction is drawn out; the student will go to sleep. Above 160, the rate is too fast for the student to grasp the facts being presented. Imitate the technique of a sight-seeing bus in your speed of delivery. As it passes the uninteresting buildings it speeds up. When it comes to an important building it slows down. Occasionally, before an historic landmark, it comes to a complete stop.

Change the tone of your voice. Don't make it a deadly, sing-song monotone and lull your class to sleep. Put emphasis on important facts. Bring your voice out from under its camouflage and make it easy and interesting to listen to.

Don't use the overworked "and" to connect sentences. There are plenty of connectives that can be used, such as *in view of, not-*

withstanding, therefore, and similar words. Try some of them. After all, you can't treat sentences as strung beads. Hook them together, but don't use the "and" hook. You are liable to get caught in your own barbs. When you pause, do it cleanly. Don't allow yourself to be an "er'er". If you need an instant to form your next thought into words, pause for it, but don't let out an "er" in that pause. Make it clean.

Speaking of pause, this might be a good time to mention our own "paws" or hands. Hands will give the potential instructor more trouble than he will usually expect, until he finds out what to do with them, and can do it without thinking. Movement of the hands will always draw the attention of a class. For this reason the movements must be controlled in such a manner that they do not distract the attention of the class from the subject. Don't be a hand wringer or washer. The student will always be watching your hands to see if you do a good job on them. Let the hands hang naturally at the sides or lift them when you want to emphasize a point by gestures. You may rest your hands on the stand or table before you, but don't take a death grasp on it. Many people put their hands in their pockets. I do it myself. It is not a desirable habit. If you limit yourself to one hand, it is not too bad—but never both hands. Above all, don't hold a piece of chalk or other small object in your hand and constantly turn it about or play with it. That is a hard thing to avoid doing, especially when you are using a blackboard and have chalk in your hand almost constantly. The main thing with hands is: if you must move them about or fiddle with something, either make that movement as small as possible, or make it useful.

Continuing the movement idea, make all your movements as purposeful as possible. Don't take a beat in front of the class and pace back and forth. Movement from speaker stand to blackboard, or to charts being used, is of course necessary. Unnecessary movement, especially if in a regular pattern, distracts the students' attention. This does not mean that you must stand in one position at all times. You can move about, but do it in such a way that it does not form a definite pattern, and don't do too much of it. Move occasionally from one side of the room to the other, seemingly to have a closer contact with the students at that side of the room. Actually, it is to allow you movement

about, instead of being stuck in one place. If you are using a blackboard, you will find that movement to and from the board is all you will need.

The lecture type of instruction, which is the most common type, is in itself monotonous and tiring. However, by using visual training aids, the lecture can be made into an interesting discourse. But, the proper use of these aids is essential. Otherwise they will fail in their purpose. Let's take a common one, the blackboard, and see how to handle it. First of all, never talk to the board. If you are putting something on the board, stop talking until you can turn and face the class. Then explain what you have put on the board. Make your diagrams and sketches as simple as possible and large enough for all the class to see clearly. It might be well to practice drawing simple diagrams and sketches beforehand. Don't use your hand as an eraser. It is sloppy and leaves a poor impression on the class. When explaining something on the board, stand to one side and face the class. This also applies to the use of prepared charts. When using a pointer, you may turn your head enough to place the pointer accurately, then again face the class for the explanation of the point. Talking to a blackboard or chart is a common fault, but it can be overcome. When you have finished with a chart or drawing on the board, remove it. Don't leave it there to distract the attention of the students from further instruction.

Training films are the best aid available for the lecture type of instruction, possibly because they make use of the national habit of acquiring information from motion pictures. In using training films, or film strips, arrange the instruction in such a manner that the film will act as a review of the lecture. This provides repetition of facts, making it easier for the student to retain them. Film strips require explanation by the instructor as each picture is shown. Strips should be gone over beforehand and remarks prepared for each picture, bringing out the essential points shown. In this way, complete coverage of a subject can be accomplished, appealing to both the sight and hearing senses of the student.

While we are on the subject of training aids, there is another important item to consider. When you are arranging for a class, be sure you have all the equipment and training aids for the instruction as you have planned it. Check over your equipment beforehand. It

is extremely embarrassing, and detracts from the final results of the instruction, to find when half-way through a course that some vital training aid is missing. Be sure you have what you need and arrange it in proper sequence for use before you start.

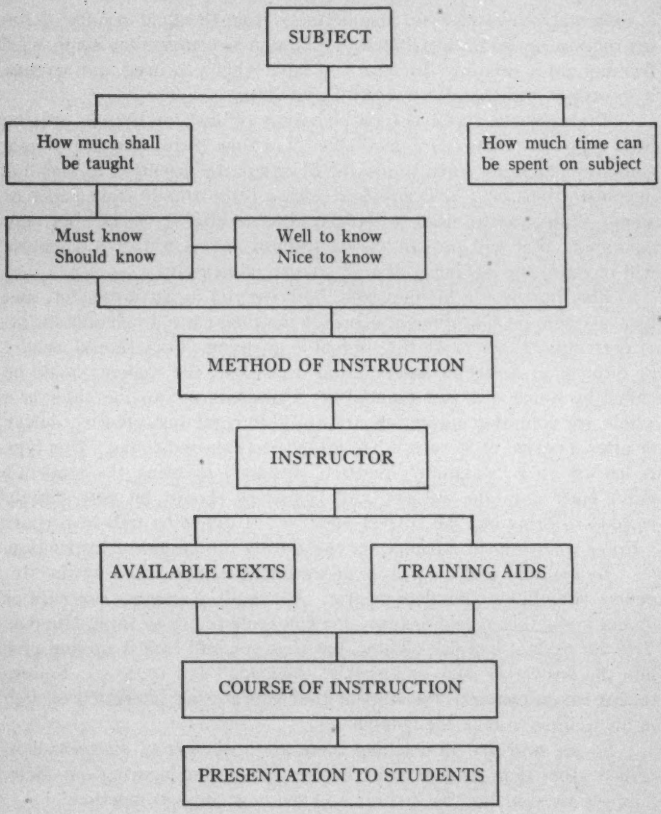
Training aids need not be elaborate. Films, of course, are the best type when they are available. Lacking them, prepare simple charts or diagrams, learn to use the blackboard efficiently. Models for demonstrations may be improvised with a little trouble from paper or wood. Slides can be used to replace films or charts. Remember, any equipment that will provide visual training, when added to a lecture will increase the efficiency of that lecture immensely.

Finally, the use of questions, both by you as an instructor, and by the students. Questions put by the instructor are a valuable means of determining how much the student is grasping. They should usually be directed at a specific student, and if possible, the student should be called by name, not just pointed at. Questions put to the class as a whole, for volunteer answering, are useful in regaining attention during or after a period of lecture, when interest has started to lag. This type is known as a "wake-up" question, designed to bring the student's mind back onto the subject. All questions should be very clearly worded to bring out the correct answers. It might be well to prepare a list of questions in advance for use during the period of instruction.

Be pleasant and helpful in answering questions asked by the students. Give him a complete answer. Above all, if you are not sure or do not know the correct answer, don't hesitate or try to formulate one. Tell the student you don't know, but that you will look it up and give him the answer as soon as possible. And don't fail to do so. Failure in this would convince the student that you are not interested enough in his welfare to take the trouble.

So, we find that in teaching there are a number of elements concerned other than just standing before a class and pouring out facts. Suppose we put them in a chart and see how they go together.

Some time ago we started out with the subject that we have to teach, and in determining the method of instruction we have to take into consideration how much to teach and our time limit in teaching it. Those two factors determine the method of instruction that we are going to use. Following that the instructor takes into consideration the


SUBJECT
How much shall be taught
How much time can be spent on subject
Must know
Should know
Well to know
Nice to know
METHOD OF INSTRUCTION
INSTRUCTOR
AVAILABLE TEXTS
TRAINING AIDS
COURSE OF INSTRUCTION
PRESENTATION TO STUDENTS

text that he has on the subject and the available training aids, and using his efforts to use those he plans out his actual course of instruction. All of those various steps go into making up the actual teaching process. It is a big job and one that is not too easy today. You will spend a lot of time studying and a lot of time practicing, perhaps.

There are very few people who cannot present a half-way decent course of instruction in a subject with which they are familiar. If you are trying to give a lesson in something with which you are not entirely familiar it is going to be harder; but if you are familiar with the subject, with a little practice and a little study you will do all right.

It has been said that the appropriate time to give instruction is at that point in the individual's experience when the need for instruction is obvious to him. I hope I have been successful in making that need obvious.

DELAYED-ACTION BOMBS AND BOMB RECONNAISSANCE

BY ROBERT L. STARR*

The fact that we are at a long distance from Europe, separated by a wide sea, does not protect us. The airplane has a long range, and we can, I think, definitely expect that we shall be bombed sometime before this war is over; maybe not in raids of great severity, but in nuisance or token raids: to give us something to think and worry about.

In bombing raids, a lot of bombs are bound to be dropped that do not explode; some of them due to mechanical failure of their detonating devices, plain, ordinary duds that just won't explode; others with delayed-action fuses. Since all unexploded bombs are buried in the ground, where we can't examine them, each and every bomb that does not explode has to be treated as if it had a delayed-action fuse.

The ordinary civilian will stand a great deal of bombing. He did it in England. He knew the enemy was trying to destroy production facilities so he came right back and went to work. But that same civilian, while he will stand the bombing, by bombs that do explode, is not going to sit around with any great degree of comfort if there is an unexploded bomb in his neighborhood, and nothing is done about it. He doesn't like it. The bomb is a potential menace, and even while it is lying there as an unexploded bomb it is doing a great deal of damage. It is doing damage to the war effort by stopping production in any important factory close to which it may be. Furthermore, the unexploded bomb may require the evacuation of people from the area around it, which means that they have to be taken to some possibly remote location where there are emergency housing facilities. The evacuees, then, probably can't get to their work as fast as they ordinarily would, and that is holding up war production. In addition, the unexploded bomb may interrupt the operation of vital public utilities. An unexploded bomb lying in or near a power plant, water works, or similar structure may require stoppage of operations of the plant, and the people served by it are going to suffer as a result. Possibly factories supplied by that plant may suffer also.

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All these disruptions are caused by an unexploded bomb. If a bomb does explode when it falls, it may be possible to repair the damage caused pretty fast. In a lot of cases, particularly in Russia, it has been reported that the morning after the bombing raid, practically no signs of damage are left; practically all damage has been cleaned up before daylight came. Frequently, the damage done by the bombs that do explode can be repaired in a short time permitting the return to work, but the ones that do not explode are something else. You may have to contend with the moving of the civilian population and the guarding of the area when it has been completely evacuated. In addition, two or three days may elapse while every activity in the area is stopped. Then perhaps the bomb explodes before it can be removed and the damage must be repaired anyway. All of this means that the bomb has succeeded in holding up vital war production for a long period, sometimes much longer than the bomb that exploded when it fell.

For these reasons the bomb disposal personnel often do not bother to remove the bomb but blow it up. Then repair crews can get to work and repair the damage, depending, of course, on the structures that are affected by the bomb. In England it was found that it was quite satisfactory, particularly in connection with railroads, to blow up the bomb and then repair the track. This was a much quicker procedure. It required less labor than is needed to dig up the bomb and remove it in order to save damage to the track. This is just an example of what can be done.

I imagine that much the same thing can be done in connection with pipe lines and similar structures, including water mains. When a bomb explodes, it may break the main. Until it does explode, the water, to be sure, continues to flow, and it might be worthwhile to try to make the bomb safe and remove it. But in a number of cases it would be definitely to the advantage of everybody concerned to blow up the bomb and proceed with the repair of the pipe line. This requires decision on the spot by whoever is going to do the work, usually the bomb disposal officer.

Relative to unexploded bombs, I am going to state mainly English experience with German bombs, for that is where most of our information has come from. Out of all the bombs that fell on England about

10% did not explode, but all of those were not delayed-action bombs. Only about 2% were of that variety. As previously stated, due to the fact that all such bombs, outside of a very small number, are buried in the ground, all must be treated, however, as delayed-action bombs. Much work is entailed in this connection. In one particular London district in one night, 88 unexploded bombs fell. This required almost the total evacuation of an entire district.

German bombs of the delayed-action type, are time fused, set to operate anywhere from zero to eighty hours. That is a long time to hold up production, if they are set at their maximum time limit. I will admit that all of them did not go off, even when they had been set. A few bombs just fall, and that is all there is to it. But until they are taken out and made safe, they must all be considered bombs that will go off at a predetermined time, and safety measures must be applied to every bomb.

Let us now turn to the finding of bombs: the bomb reconnaissance itself. We have an awfully large area in this country. Even limiting it to the coast lines, it is still a large area. The Army could not do the job of finding bombs—not unless they put the whole Army on it, and then we would not have anybody left to do the fighting. As a result, the Office of Civilian Defense and its various organizations have been assigned the task of finding and reporting unexploded bombs. The agents used for that purpose are trained by the Army. Bomb reconnaissance, finding the bombs, identifying them and reporting them, are duties of the Office of Civilian Defense.

A lot of importance should be placed on finding the bombs; first of all, to establish their location and what they affect. A lot of unexploded bombs do not affect anything—at least nothing important. They do not have to be worried about too much and can be taken care of in their turn. But a lot of them are very important; they affect vital installations, and the sooner they are found and reported, the quicker can the Army dispose of them.

The trained bomb reconnaissance agent is a vital link in the chain of bomb disposal. He must get on the job, do his work, and get his report in fast. His primary duty is finding the bomb, looking over the area, seeing what installations are affected, and reporting the facts connected with the bomb to the Army so that the bomb disposal organ-

ization of the Army has something to work on. The Army can then allot its working program. In addition, the bomb reconnaissance agent plays an important part in eliminating false reports. Until November 1, 1942, around 450,000 bombs were dropped on England. Some 88,000 reports of unexploded bombs were received. When the bomb disposal officers actually got to the scene and looked the bombs over, they finally found that only 23,000 reports were correct. The rest were false; perhaps because a bomb reconnaissance agent did not go to the scene and investigate, accepting somebody else's word for it. The bomb reconnaissance agent should make a personal investigation of each and every incident and should not take anybody else's word for it. Otherwise there may be a false report, and the minute that report is turned in, all the auxiliary agencies of the OCD go into action, and there may be an unnecessary evacuation of the people in that area, and things of that kind.

The reconnaissance helps to establish what we call the category of the bomb. In other words, a priority for its disposal. The facts turned in by the reconnaissance agent determine the category of the bomb, according to the importance of the installations that it affects, and as a result the priority in which it is going to be disposed of. Naturally those bombs that affect important objects are going to be taken care of first.

The Army has set up a policy that until a bomb is reported by the OCD, the Army does not even care whether there is a bomb in existence or not. It must be reported; when it is the Army will go to work. Even in Army reservations, the reporting channel is through the OCD, so that all reports go to the bomb disposal officer through one channel, not through half a dozen. That eliminates duplicate reports.

The reporting system of the OCD starts out with the air raid warden or the ordinary civilian finding a suspicious hole in the ground that he thinks may have been caused by an unexploded bomb. He reports the circumstances to the local control center or the local report center. Here are a number of bomb reconnaissance agents, depending on the size of the area that the center covers. Immediately on receiving the report, the agent should go to the scene and investigate the report, and notify his control center. Thence a telephone message is sent to the district warning center, and the district warning center communi-

cates directly with the Army. Following up the telephone report is a written report made out by the bomb reconnaissance agent, sent to the district warning center, where the category official is stationed. He puts that bomb in its proper category for disposal. The written report is distributed down through to the state headquarters, and when the bomb disposal officer arrives in the area to go to work he stops at the district warning center and picks up copies of all reports—he gets the original copies of all reports that have come into the district warning center and he gets them all in one place. He can then plan his order of work. He knows exactly what he has to do.

Bombs are placed in three classes, A, B, and C. Category A covers bombs that affect vital installations necessary to the war effort, such as a large airplane factory and a power plant that is supplying energy to important defense factories. Category B covers those bombs that are important but the removal of which does not vitally affect the war effort, such as bombs in thickly settled residential areas, where a large number of people will have to be evacuated, or possibly bombs in the main street of a town where they constitute a definite hindrance to traffic but not too large to affect the war effort. All other bombs, those out in open spaces, in a park, for instance, or out in the country, are put in category C. They will be taken care of after all category A and B bombs have been disposed of.

In the majority of cases, there is a "safety period" which, for German bombs, is ninety-six hours. But if we are dealing with a category A bomb we do not wait ninety-six hours but go to work as soon as we can get there, although there is risk to the personnel. Category B and C bombs can wait until the safety period has run out, so that if they are going to blow they will do so, and the damage can then be repaired. The only person who has authority to make any alteration in the category is the bomb disposal official himself when he arrives on the scene. If he can take some protective measure to reduce the category of the bomb that is his privilege. He may think, too, that the bomb was originally placed in a wrong category and does not affect vital installations as much as it was first thought to.

Let us take a short look at some of the bombs themselves. There are two general types of high-explosive bombs, one the general-purpose or demolition bomb running, in the case of German bombs, from 110 lb. in weight to 4,000 lb. The general-purpose type bomb is a thin-

case bomb, containing quite a high quantity of explosive, in relation to its weight. Actually the explosive weight ratio is something like 55 to 45; about 55% of explosive and 45% of metal making up the total weight of the bomb. That high quantity of explosive will do a great deal of damage in the form of blast—blast from the actual detonation of the explosive itself. The demolition bomb is used primarily against buildings of not too strong construction, mainly to create damage over as wide an area as possible. It is the most common type of bomb.

The armor-piercing bomb is used against targets of unusually strong construction, such as battleships, fortifications, and strongly built power stations. These bombs have a very thick, heavy case, so that they will penetrate a tough target. Their explosive content is relatively low, about 25 to 75 or 25% explosive and 75% metal. When they explode their damage is not quite so great, as far as demolition is concerned, but the fact that they are designed to penetrate their target and then explode makes it possible for them to create their damage inside the target. The armor-piercing bomb runs from 110 lb. up to 3800 lb. in weight. Incidentally, the size of both types of bombs corresponds to their weight. The 110-lb. bomb is about 8 inches in diameter, and sizes run up from that.

In addition to bombs, other things will be found after an air raid: unexploded anti-aircraft shells, parachute mines, and parachute flares. They all present potential hazards. You can't go around kicking them, picking them up, or keeping them as souvenirs—particularly not parachute mines; they are more dangerous than bombs. Mines have an extremely high weight ratio, about 80% of their weight being explosive. When one of them explodes, damage is created over an extremely wide area. All of these things must be reported by the bomb reconnaissance agent. Some of them, such as anti-aircraft shells, do not require evacuation. As long as they are not disturbed they are safe.

At the present time, during the scrap metal drive, every child in the city is going around collecting every piece of scrap metal that he finds. He has been told to do so. Once we have had an air raid, however, that must stop. The children don't know one piece of metal from another so far as bombs, shells, and the like are concerned, and picking up scrap metal becomes too dangerous. That stuff can't be disturbed carelessly; it has to be done by somebody who knows what he is doing.

WHEN THE BOMBS FALL

BY ALBERT B. KONZ*

I will try to give you as close as possible a picture of the British ARP setup. I joined the service in February, 1940, as a warden, and tried to get into the service for a couple of months before that but the fact that I was an American and an alien to England made it necessary for me to go through quite a bit of registering and investigation by Scotland Yard, but finally they let me in.

The British air raid warden is the man in the street. He is the man who works in the stores and the factories. He goes through quite a bit of training before he is allowed to operate by himself. He goes to school three nights a week, usually, two hours a night, for a period of ten weeks. When he joins the ARP service, he takes a general course. While he is taking the general course he decides whether he wants to belong to the demolition squads, the decontamination squads, the first-aid squads, stretcher bearers, auxiliary fire service, or any of the other of the many branches of the British ARP system.

After he goes through this training he graduates. And incidentally, if he misses more than three nights during his course he must start again. After he is assigned to the group of his choice, he starts to train again. If he joins the decontamination squad he is taught about gases, how to cleanse, how to apply first aid to gas cases. Demolition men are taught how to remove debris without crushing the victims that are buried beneath it. The stretcher men take a course in first aid and learn how to move a patient. The mobile, first-aid units are taught advanced first aid. That training takes quite a while, and then they get a certificate much like the Red Cross certificate in this country. It is a St. John's Ambulance certificate.

If a man becomes a warden, he pounds the beat in the same manner as a policeman. The new man is put out with another warden, who is a seasoned man. He is then taught where the various fire hydrants are, the electrical equipment in the sector, the gas cocks,

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the water cocks for the various homes, and anything else pertaining to his sector that he should know during a raid.

The warden in England is well equipped. You must remember that the German air fields are just across the Channel, not more than 60 miles from London, and that is too close for comfort. The warden receives from the government a full uniform, the British army uniform, in blue. He is equipped with pants, leggings, hobnailed boots, which are heavy and very good, tin hat, blouse, respirator, and so forth. The reason he receives this equipment is because in England being an air raid warden sometimes is a very dirty job. The government provides 60 clothing coupons a year; since it takes 27 coupons for a suit and 27 for an overcoat, not much would be left for every-day clothes, if the government did not supply the necessary clothing for warden duty, good warm clothing, too.

The fledgling warden is taught how to answer the telephone, and is then taken out on duty and is shown the various homes, the characteristics of the sector, which houses are usually the blackout offenders, which ones have been warned, whom to watch out for. He is introduced to the fire watchers at the various factories and apartment houses and generally gets to know the sector. He works with the instructing warden for a period of three or four weeks.

The British air raid warden has been on duty twenty-four hours a day since war was declared. During the daytime the duties are taken up by paid wardens, men who have come into the service and receive a salary. At nighttime, after seven o'clock, the volunteer comes on. That is the time we usually have trouble. The volunteer goes on duty, say, at seven o'clock, and he gets off at eleven. He is relieved at eleven by another warden who takes up the duty until seven o'clock in the morning, when the paid warden again comes on.

The preliminary, or preraid, training stood us in good stead when the Jerry bombers started to come over. The ARP post is a brick building with a 13½-inch wall and an 8-inch precast concrete roof that will stand a blast of a 500-pound bomb at 50 feet. Those posts are placed about three or four blocks apart throughout the city. For every six posts there is a key post, which is a reporting post for its surroundings posts. Those posts are equipped with telephone and bed, a place to make tea, heating equipment, electric lights, and usually a

radio that is supplied by the people in the district. It is a comfortable place. It has to be a comfortable place as you spend a lot of hours in it.

Once a week, or sometimes twice a week, there are meetings. Those are post meetings, and every warden is supposed to attend. If he is not there, he usually has to have a very good excuse, because it is not the government, or the city, that gets after him but the other wardens. Attendance at meetings is something of which the posts are rather jealous. During those meetings, we would sometimes have a man come from Control, who would come into the post and say, "We are going to have an incident starting now; two wardens will go on duty." The two men that are on duty that night will leave the meeting and go out on the sector. When they arrive on their sector they will find perhaps a live incendiary bomb burning, or perhaps two of them; they will find people in the streets with tags on them and the tags will tell the first aid parties or the wardens exactly the trouble with the victim; they will find oily marks and perhaps oil splashes on buildings; and they will make out a report exactly as if it was a real, live raid, an active raid. The report will come into the post and be relayed to Control. The wardens at the meeting will then go on duty and be assigned to their various duties.

The duties of the air raid warden in England, or in Britain, during a raid is to mobilize the services as they come into his sector. The warden will mobilize the first aid parties on one side of the street, the stretcher parties on the other side of the street. They will have a hydrant uncoupled for the fire service. They will bring up demolition squads to the scene of the incident and get them away as soon as they have dropped their equipment, give the fire department right of way, keep everything well controlled, and if necessary evacuate people from "unexploded bomb" sections.

The British air raid warden does not get very much training in first aid. He is taught how to treat shock, stop bleeding, and that sort of thing, but he does not get an extensive first-aid course. That is left to the first-aid parties, who are really trained for that, and the stretcher parties. When the report goes back to the post and is relayed to Control, the other services, such as demolition, stretcher parties, and first aid, are mobilized. They are not expecting a practical incident that

night either, and when the report goes through to Control it is relayed to these other depots, and those services roll. It is as unexpected to those services as it is to the air raid warden at his meeting. It is that preliminary training that the British air raid warden received before the raid that stood him in such good stead when Jerry did come over.

It has been said by men high in the British government that the British army during the Battle of Britain was inactive. They could not be active. There was nothing for them to do. The Navy could not help. The RAF did the job. It has been said that the RAF did the job in the skies during the day, but we had our raids at night and it was a long time before we had any night fighters to drive off Jerry, and it was quite a number of weeks before we really heard any ack-ack —anti-aircraft fire—to try to drive him off. So that it has been said that the British air raid service went a long way towards saving Britain during the Battle of Britain, and it was because, as I will say again, of their preraid training, their proper training, that they were efficient during the raids.

Our raids started at the end of August, 1940. We had our first raid, our first real raid, on a Saturday in September. It started about three o'clock in the afternon and went on all through the night, and it did not stop until December 24. Our boys, myself included, did not have their clothes off nor did we sleep in our own beds for one minute except Saturday afternoons and Sundays during that time. The boys slept in hallways if they had a break of an hour or two during the evening.

The air raid warden at the beginning of the raids was told, "Don't take any chances, stay under cover when the raids start; an air raid warden as a casualty will take up the place in an ambulance that a civilian should have, and not only that but he is weakening his own sector or his own squad." That is what they told us at the beginning of the raids. But we found out that we had to be out every single minute, because when incendiary bombs started to drop—they did not make much noise when they came down—and if you did not see them come down and go through a roof, the first you would know about it would be when the blaze broke through, and then it would be too late.

Because of the blackout, every house and every factory in every

street in England was black. We did not allow a pinhole of light. Because of that you could not see any incendiary bombs that fell in a building until they burned down the blackout curtain or the blaze came through the roof.

Then we had high-explosive bombs. When Jerry dropped them, he usually dropped them in sticks of six. Four of those would be live bombs and they would explode, and usually two were UXB—unexploded bombs. Those bombs would bury themselves perhaps in soft ground. They would come down and appear to be exploded, especially if they had a head ring on the top of them. Jerry put those rings on so the bombs would churn up the ground as they came down, to give the ground the appearance of the bomb having exploded. Those bombs, when they were dropped, had to be found, and it was up to the air raid warden to find them. When their presence was suspected the air raid wardens would form a line, with their hands extended, and go across a field until they discovered a hole. Then the wardens would leave, but the senior warden had to stay and identify the bomb. Then he, too, would get away as quickly as possible and would notify the Army bomb disposal squad, in the case of a bomb, and the Navy, in case of a mine. That was done, of course, through Control.

Besides bombs we had mines. There were four types of mines. They weighed a thousand or more pounds and came down on parachutes. Coming down at forty miles an hour, they sounded like a truck coming down the street with a flat tire, because the parachute flapped in the air. The first type of mine did not need to be identified. It was the instantaneous mine that blew up. If it blew in the center of four streets of houses, or in back of four streets of houses, it would lay those houses flat. Then we had the acoustic mine. That mine came down and rested on the top of the earth, and it had a sound box in it that was tuned in sympathy with some sound, either a whistle or the click of a heel or the ringing of a doorbell, the honking of a horn or the pitch of your voice. Then we had the magnetic mine which detonated in sympathy with metal. If you went close to it with your tin hat on, it would blow; if you went close to it with a silver plate in your head it would blow. The fourth one was the delayed action mine. You never knew when it was going to go off. It just sat there until it exploded or until the Navy came along and took out the mechanism.

They usually were on the job pretty quick, and it did not take them long to kill the mine. But we had to be careful. Coming down at a rate of 40 miles an hour the mines would penetrate the soft ground and a part of their blasting force would be lost. Parachutes were used to prevent this and to preserve the delicate mechanism that controlled them.

In the raids and blitzes—and they have had *some* blitzes in the raids that I have been in—I have never seen any panic. I have never heard anybody say, "Let's quit." The raids just seemed to make the British mad, and the next day they went back to work. We never attempted to stop them. They could go to their work even during a raid, without being bothered. When the raids first started we did stop travel for a week, but when we found out that raids were going to occur every night and that production would naturally drop off if we kept the people away from the factories, they were given permission to travel to work by foot, trains, buses, or in their own cars if they could get the petrol. After the first ten days of the raids, production in England went up, because, as I say, the people were not made downhearted by the raids, it bucked them up. They are a determined people, and Jerry will never win as long as there is one man left on the British Isles.

Shelters were provided for civilians. When the raids started, there were not very many shelters, but it did not take very long for them to be put up. They were put up in blocks to hold fifty people, with one entrance and an escape hatch. They were equipped with electric lights, a plug to make tea, and bunks. The civilians provided their own blankets. The same people gathered in the same shelters every night, and if you visited a shelter, it was like going to a party. The people inside usually had some sort of music and they entertained themselves.

I think the worst raid on London was the raid of May 11, 1941. It was a Saturday night. The RAF shot down thirty-three raiders out of about five hundred, I believe. The anti-aircraft did not get them, but that kept them up. Four of them fell in our surrounding sectors. They were surprised to see the night fighters on their tails. It had taken a long time to develop night fighters, but when they started dishing it out, as they say over there, they did a good job.

On May 11, 1941, the city of London was ablaze. During the first fire raid on December 29, 1940, the fire fighters had to depend on the city water supply to extinguish fires. They did a pretty good job, but they could not pump water from the Thames because Jerry pulled that raid during low tide. But by the time of the next big fire raids, a few months later, and the one of May 11, 1941, the British government had laid pipes into the river and carried them through the city as huge metal pipes. They also took the cellars of bombed houses and lined them with concrete and made reservoirs from which they could pump water. If it had not been for that, I am afraid the raid of May 11 would have been much worse than it was, and it was bad enough. The boys were fighting fires; they would be right up on the edge of the fires; and they would look behind them and see that they were hemmed in, and would have to run to get out. They would have to leave their equipment and get out to the edge of the fire again and fight it again. They fought those fires with small Coventry 500 g.p.m. pumps. They did not use large equipment. The large equipment was used for fires in the suburbs, because the heavy equipment was cumbersome, and when a building came down it was necessary to abandon the equipment.

Fire bombs weighing 2.2 lb. often came down in sticks of fifty-two to start fires. They would penetrate roofs and burn through the other floors. We would put a bag of sand over them outside if they were in a dangerous spot. Inside the house we had to pick them up with a shovel and throw them out of the window or fight them with a spray. Now they say to fight with a jet. I have never fought with a jet. We turned the jet on accidentally once and we had an awful spatter and went back to the spray.

Oil bombs consisted of cylinders filled with oil which was taken from aeroplanes when they drained the crankcases. The Germans threw those at us. The bombs were supposed to ignite. I do not remember ever seeing one of those oil bombs do this. Finally they started throwing them into the fires that had been started. When they missed and hit a house or the street it made a very bad and slippery mess.

One of the comforts of the warden was the mobile canteen which generally distributed rations to the post in the middle of the night. You must remember that this represented an extra meal. The men worked

days and were often on duty all night. When it came two or three o'clock in the morning, they wanted a cup of tea, a sandwich, or a piece of cake. With our personal rations we couldn't afford a snack in the middle of the night. At that time we were getting twenty cents worth of meat a week, one egg a month—when you could get it. I remember that there were eight months when I never saw an egg; I forgot what an egg looked like. We had no fruit, and you could have bought a house with a lemon. We didn't have onions until we grew them ourselves. But still we were healthy. They had no icing on their cakes after the first six months of the war. The cakes were made out of brown flour. Bread was made out of brown flour. Two ounces of butter a week, four ounces of margerine, and two ounces of cooking fat, and still people did not complain. When I got back on the boat in Scotland a few months ago and I sat down to a table and saw six months rationing of butter and fruit, a piece of meat that I couldn't eat because it was so big, and lemons, and a cantaloupe and a cocktail, I almost cried.

As to incidents, I remember one in the next sector to us in Hendon. A bomb came down, a demolition bomb, I imagine meant for the Hendon air field, but it landed in a group of houses and laid three streets of houses flat. Quite a few people were killed, a couple of hundred, at least, and as many more seriously injured. The exact figures were never given. That incident went through without confusion after the first fifteen minutes. After the incident officer arrived, the services reported to the incident officer and were assigned to their various duties. I saw no confusion among the services, no arguments among the foremen of the services. The fire department did its job independently of the ARP services, and the services did their jobs through the incident officer. The reason for success was preraid training. The warden took his job seriously in the face of ridicule and criticism, which he did get from the public before the raids started. I remember many times being out in uniform practicing, picking up children in the street with tags on them. We were putting the children in the ambulances, and they were taken to the hospital and then all brought back again. People going down the street would say, "Look at those big men playing boys' games." But instead of that criticism, when the raids did start, the warden was looked upon as the best

friend of the residents of his sector. They would call you out at three o'clock in the morning because they heard something come down. They would call you out because they suspected something was in their back yard. Perhaps a cat jumped over a fence. They would knock on the Post door at two o'clock in the morning and say, "Are we likely to have a raid tonight?" They cultivated the warden.

In another bad raid in the southwest part of London a bomb came down and hit the entrance to a subway shelter, and another bomb in the same stick hit the middle of the street and fractured the water main and the gas main and drowned the people in the shelter. That was a bad raid.

We had a fire raid on our sector. In peacetime it was an exhibition ground that had been converted into a park. The Army took it over, and then the RAF, after the war broke out, and they used it as a storage dump for tires. Tires were collected there and were used for recapping. Incendiary bombs came down that night and it looked like fairlyand. We extinguished all the bombs with the exception of one that had fallen among the tires. We opened the incident at two past twelve midnight and closed it at two-thirty the next afternoon. The Germans threw oil bombs at us that night after they had that fire started. They hit eight houses within two blocks of the incident and they never hit the incident, and I am glad they did not. I lived about a half block from it. During that night there were no casualties to our boys, thank God. That night we had 82 fires in the district, and that one in our sector. When I say sector, I mean a section of perhaps four blocks that the senior warden is charged with. We had a stream running through our sector, and the boys took the pumps away from the hydrants to give water to the other incidents in the district and we pumped out of the stream and kept that fire down. We had it under control at about six o'clock in the morning but it did not die down until that afternoon. That was a pretty sticky one.

Now about the duties of the senior warden. He acted as incident officer during a raid when he was on duty—and he was on duty at first almost all of the time, in the post or patroling the sector. Later we relieved the senior warden by a deputy senior warden, and finally, when the raids occurred every night, he was given two deputy senior wardens after two months, but the senior warden always changed the

wardens at midnight. The senior warden also investigated the incidents in his sector.

I remember being in the post when a man came in and said that something came through his roof. We went up to his house, and saw a pretty bad hole in the roof and a hole in the floor. We put our hands down into the hole and found a 250-lb. bomb. The man had been sitting on it a half hour before he decided to come up and tell the air raid warden that it was there. It did not blow for eight days.

[The following questions were answered by Mr. Konz]:

Q. By what power do they run the small pumps? A. They are run by small gasoline motors built by British Ford.

Q. What power does the warden have during a raid? A. Wardens have power of entry to extinguish fires, to put out exposed lights, and to generally direct the public during a raid.

Q. Were there many casualties among the wardens? A. Quite a few. I don't know the figures, but it did run into many hundreds.

Q. I would like to ask about the 4-lb. combination incendiary and explosive bomb which has been out for the past six months or so. How did its use change the procedure of the wardens in comparison with handling the 2-pound magnesium bomb. A. Up until the last raid on London the other night this bomb had not been used in London. It had been used on Hull, and I understand on Dover. We had experience with the anti-personnel incendiary bomb, an explosive bomb. Up in its top a little visible button blew the top off. Lots of times it would not explode on impact and it was not effective. It would scare you but it would not do any damage. In another one a cylinder, about a half inch by an inch and a half, was tucked into the top of the incendiary bomb. While it could be seen, it was dangerous; it would blow your head off. The cylinder was put in there as an anti-personnel bomb, and also to scatter the magnesium, if it came down in a house, a factory, or place that might be vulnerable. Later the Germans tucked the cylinder further into the bomb, but still you could detect them. After two minutes, the flame took on a green hue, and as soon as you saw the green hue you could get away from it.

Q. A man told us a short while ago that panic was a major issue in the raids although it was not known here. A. I have been in over five hundred raids in a thickly populated section and I have not seen any panic at all.

Q. Were you on duty all the time during a series of raids as warden, or practically all the time at night? A. We went on duty when the raids first started. You see when the raids started we had never been in a raid and we didn't know exactly what it was all about. We didn't know whether they were going to raid us every night or whether we were going to get raids for an hour a night every night, or were going to get them three or four times a week, or once a month. It was not until we found out that we were in for a long siege of raids that we split up the duties. At first we were on duty all night long; then we were on duty the first part of the night until twelve o'clock, and another shift took over from twelve o'clock and the other wardens slept in their clothes in the post or in a hallway, ready for duty if they were called out. That went on, as I say, until December 24, which was the first night on which we did not have a raid since September. We had three nights then—Christmas Eve, Christmas, and the night after—without raids. It was not because Jerry was kind hearted and had the Christmas spirit but it was because the weather was so awful that he could not fly.

Q. How did you carry on your regular work in the daytime during those periods? A. On Saturday afternoon and Sunday we got as much sleep as we could. After the first few weeks we did get, as I say, a little sleep before twelve or a little after, if the raid was not too bad. If our sector was not the target for the night we had a little sleep, but not more than two and one-half or three hours, in our clothes and in a hallway. People were good to us; they would provide us with blankets to cover us up, or bring us a pillow and try to keep us warm.

Q. Did the military disclose to the civilian wardens their process of neutralizing the fuses in bombs? A. No; that was a military and naval job.

Q. Do they have auxiliary police in Britain? A. Yes, they had an auxiliary police service. The auxiliary service was brought into the regular service at the declaration of war; every man in the auxiliary service was full time in the regular service.

EFFECTS OF BOMBINGS ON STRUCTURES AND OTHER INSTALLATIONS

BY WALTER C. VOSS*

When I was asked to prepare a paper for your group I was very much in doubt as to the amount of information definitely available that would be of use to your group which is undoubtedly interested in a more or less logical approach to the problem of damage that might be expected from high explosive bombs on structures having to do with the supply of water and the disposal of waste. In considering what I will have to say you will be continually confronted with the query as to how one might know just where a bomb would drop. What I have to say therefore is from an entirely different angle, namely, to give you certain empirical information as to the distance away from the position of an exploded or unexploded bomb that one might expect damage to sub-surface services. I shall not spend any time on those matters that now are well known to you, which have to do with the forces involved in the explosion of high explosive bombs of various calibers. With this you should undoubtedly acquaint yourselves. I should like to review with you, however, some of the approaches that have been made to the question of radius of destruction by previous investigators over the past fifty or more years.

One of the most useful of these is found in the British A.R.P. Handbook No. 5 entitled "Structural Defense," in which an attempt is made to define the horizontal radius of rupture for various soils. The empirical formula for the radius follows:

$$H = F\sqrt[3]{C}$$

Where H = horizontal radius of rupture, in feet
F = soil factor
C = charge of explosive, in pounds

Soil Factors[1]

Hard Rock and Reinf. Concrete	3.30

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[1] "Structural Defense," British A. R. P. Handbook 5 (adapted).

Medium Rock	3.87
Soft Rock	4.29
Blue Clay	6.18
Loam	6.67
Gravel	6.84
Bedded Sand, hard	7.59
Sand, medium loose	7.83
Heavy Fill	7.73
Soft Fill	9.66

It must be remembered that in most high-explosive bombs there is a charge-weight ratio which may vary from 30 to 60 per cent of the gross weight of the bomb. In all of the calculations here considered the charge-weight ratio has been assumed at 50 per cent, so that one-half the weight of the bomb is considered as explosive. Another method of approach was developed by F. J. Samuely and C. W. Hamann in their book on "Civil Protection," published in London. They have attempted to define the pressure in pounds per square foot at a given distance from the point of explosion and have based this upon the radius of the camouflet cavity, the assumption that there are 2,450,000 foot-pounds of energy produced for each pound of explosive, and that the damping factor is an exponential decrease. Their general formula is as follows:

$$P_r = \frac{E_x}{8.38\, r_c\, r^2}\, e^{-\psi(r - r_c)}$$

Where P_r = Shock pressure in pounds per square foot

E_x = 2,450,000 C foot-pounds

$r_c = \beta \sqrt[3]{C}$

C = charge of explosive in pounds

r = distance from point of explosion in feet

e = 2.718

ψ = coefficient for the medium

β = coefficient depending on medium.

Values of β and ψ†

	β	ψ
Reinforced Concrete and Hard Rock	0.5	0.1
Soft Rock	0.7	0.2*
Blue Clay	1.1	0.4
Sandy Loam or Gravel	1.2	0.4*
Sand	1.5*	0.5
Compacted Fill	1.7*	0.4*

The value 8.38 appearing in the denominator of the formula is an empirical constant which has resulted from experimental data developed in England.

Let us analyze the approach of Samuely and Hamann by determining the pressure at the edge of the camouflet cavity. At this point the values of r_c and r would be equal and we would have:

$$P_c = \frac{E_x}{8.38\, r_c^3} = \frac{292000 \times C}{r_c^3} = \frac{292000}{\beta^3}$$

because $r = r_c$

It will be noted that the exponential factor becomes unity. The value of P_c can thus be expressed in terms of C and r_c, or in terms of β only. The computations necessary for determining the value of the exponential factor are long and tedious, and it is readily seen that as the distance from the explosion increases the pressure in pounds per square foot decreases very rapidly. For the purposes of this discussion let us assume that the pressure decreases inversely as the cube of the distance from the point of explosion, instead of using the exponential damping factor. If we do this, we find that the value of P_r is materially simplified:

$$P_r = \frac{r_c^3}{r^3} \times \frac{292000}{\beta^3} \text{ or}$$

$$P_r = \frac{292000\, C}{r^3}$$

Remembering that P_r is the pressure in pounds per square foot at a

†Adapted from F. J. Samuely and C. W. Hamann, "Civil Protection"—London.
*Author's suggested values.

distance of r from the point of explosion, we find that this value then becomes equal to the amount indicated. These assumptions are in error, of course, because the formula indicates that no allowance is made for the medium in which the bomb is exploding. Corrections for this discrepancy must be made by other means.

In the present emergency it will undoubtedly be realized that where complete records of all sub-surface pipes, conduits, and lines are available a much more intelligent approach to protection may be made. In most metropolitan centers and in a great many towns and other cities very complete records have been kept of the installation of all water and sewer lines as well as the location of electrical and gas lines. These records, of course, should indicate the material of which the various services are built. Where calculations are available as to the safe resistance of such services to pressure these values may be compared with the pressures developed from the formulas previously given. It must, however, be remembered that in the design of these sub-surface lines a static load is considered, while in bombing the effects of impacts are apparent. Also inasmuch as the pressures are safe pressures, there is involved a factor of safety. If this factor of safety is known, it is entirely probable that one might exceed the safe values by about up to 90 per cent of the ruptural values. Another matter which must be carefully considered is that the weakest part of any of these lines exists in the joints. For this reason I believe it is reasonably safe to allow a pressure per square foot of about 750 pounds for stoneware pipes and brick sewers; a pressure of 3,000 pounds per square foot on cast-iron and reinforced-concrete pipes; and a pressure of 6,000 pounds per square foot on steel pipes and cable lines. These values will vary of course with many of the details of construction as well as with the nature of the soil in which these lines are bedded.

An interesting check on the allowable pressure in pounds per square foot on underground pipes and conduits is given by an adaptation of Frühling's formula:

$$P_p = \frac{W_L\,(16.5 - h)^2}{300} + W_s\,(h - .06\,h^2 + .0012\,h^3)^*$$

*Adapted from Frühling's "Handbuch für Eisenbetonbau," Vol. 3.

where P_p is pressure on pipe in lb. per sq. ft.
W_L = surface live load in lb. per sq. ft.
h = depth of pipe below grade in ft.
W_s = weight of fill per cubic foot in place.

This empirical formula involves the live load on the surface of the ground above the pipe, the weight of the fill per cubic foot in place and the depth of the pipe below grade. As this is the safe pressure on the pipe and is particularly related to the backfill, there are undoubtedly errors which would creep into our use of this formula for the purposes of determining the effects of explosives on the sub-soil at a distance from the pipe, which undoubtedly is of a different material. Assuming, however, that these values are in the nature of the effects in clay soils on earthenware pipes, corrective constants may be provided for various types of sub-surface soil and for other lines. Thus the proper value that will still be safe for earthenware pipes should be 1.5 times that obtained by the Frühling formula, while for cast-iron and reinforced-concrete pipes it may be increased five times and for steel pipes and cables ten times.

Figure 1 is a plot indicating the relation between the weight of the bombs and the explosive pressure at various distances from the point of explosion. The horizontal lines for stoneware pipes and brick sewers, steel pipes and cables, and cast iron and reinforced concrete pipes are also shown. The values obtained from this diagram check very closely with those recommended by the United States Army for the distances at which the earth shock would not create substantial damage. The distances given on this chart should be varied by the factors of 1.3 for all fill, 0.9 for gravel, and 0.8 for relatively compacted sand.

There are two approaches to the use of this information, depending upon the conditions. In one instance we have the actual explosion of a bomb; in the other we have the possibility of an unexploded bomb, a so-called UXB. In either instance the object is to establish, if possible, the calibre of the bomb in question. There are more or less empirical methods of approaching an answer to this problem.

Let us study the question of the exploded bomb. In this case there will be crater and crater edge lip as shown in Figure 2. Such a contour

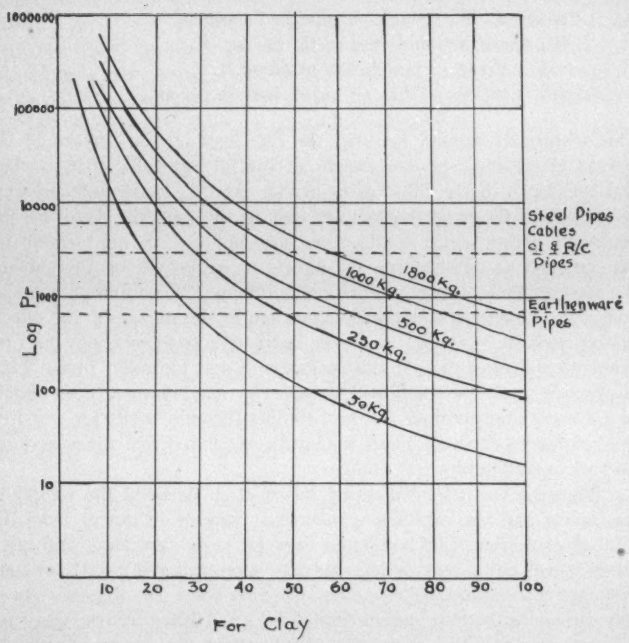

FIG. 1—PRESSURE-DISTANCE RELATIONS.

indicates the unquestionable decision that the bomb has exploded. The relation between the values indicated in Figure 2 are expressed as follows:[2]

$$C = \frac{s}{10e} L^3 (\sqrt{1 + n^2} - 0.41)^3$$

where C = Charge of explosive in pounds
s = soil factor
e = explosive factor (3.0 for T.N.T.)

[2] "Structural Defense," British A. R. P. Handbook No. 5.

L = initial depth of charge, in feet
n = index

Soil Factors s	
Fill	0.7 to 0.9
Hard Sand	1.1
Gravel	1.3
Blue Clay	1.5

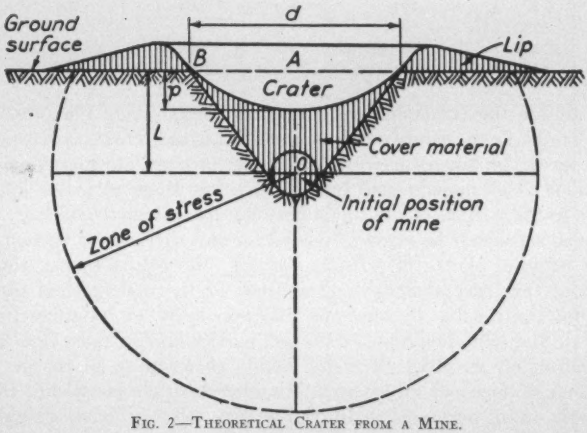

FIG. 2—THEORETICAL CRATER FROM A MINE.

In order to make this formula useful in determining the size C of an exploded bomb, one may use the curves shown in Figure 3 which are based upon a soil factor value of $s = 1.4$ and the e for T.N.T. which is 3.00. Thus, a measurement of the crater will enable one to approximate the bomb size, from which the expected radius of impairment may be determined by use of the curves in Figure 1.

In the case of UXB's the following general data are given by U. S. Military Authorities:

The holes of entry of bombs can readily be used to determine their sizes. These are given as:

Weight—kg.	*Diameter of hole—inches*
50	8 to 12
250	14 to 18
500	18 to 22
1000 or larger	26 or larger

The diameters of the casings of bombs are as follows:

German Bombs		Japanese Bombs	
Weight—kg.	*Diameter—inches*	*Weight—kg.*	*Diameter—inches*
50	8	50	7.1
250	14½	60	9.4
500	18½	60	7.85
1000	26 (Herman)	100	9.4
1800	26 (Satan)	250	14

Beside the fundamental approach of determining the pressures that are likely to disrupt services, there is another basic consideration that should be taken care of at this time. A complete survey should be made of all underground lines particularly those of major importance to the welfare of the community during extreme conditions, and an analysis should be made of possible means of isolating sections of lines between planks of possible damage. If such a survey should indicate that exceptionally long sections of the underground piping are not controllable by shut-offs, the possibility of installing intermediate shut-offs should be considered, particularly on those lines that are absolutely essential. The desirability of mapping all cut-offs for all kinds of lines and spreading information as to the location of those shut-offs to all personnel in the A.R.P. services who have a right to have access to such information cannot be overestimated.

Another precaution related to this question of survey is a determination of the amount of stand-by piping and other equipment that should be available in selected strategic positions for immediate repairs. There is no greater service that the engineer could render to his community than to analyze the possible importance of a ruptured pipe of any kind in any locality within the confines of a city or town. Such a cool analysis at this time by a group of engineers who understand the problem involved would undoubtedly bring to light many weak points and suggest many remedies. The exact thing to do at the time of the emergency or incident will undoubtedly be clouded by the confusion of mind of many on the spot and it will then be too late to do anything

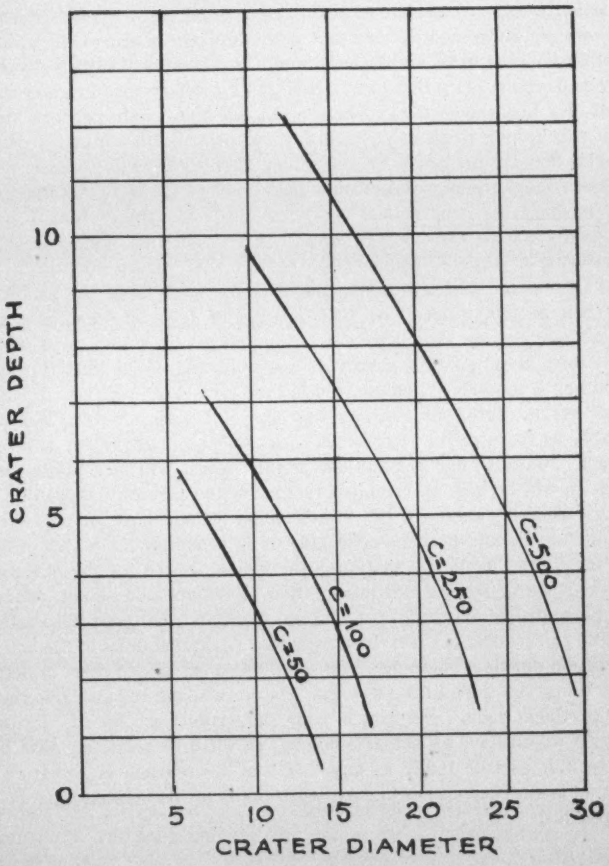

FIG. 3—CRATER SIZES.

but make temporary and perhaps erroneous corrections. If every warden who is connected with this effort, and there should be such, knows exactly what will happen if a bomb drops on any of the utilities within his post area, and exactly where the necessary repair elements are and who is to do the work, it will greatly relieve the situation when and if a bombing occurs. There is no question in the writer's mind but that taking stock of possibilities and probabilities from all of the angles that are present in an emergency of this kind will produce much better results and bigger dividends than much of the loose talk that goes on in glittering generalities. To accomplish the things that I have suggested means work, lots of work. To get this work done means the recruiting of capable engineers as members of survey squads to aid the local water and sewer department in the analysis of the problems in their particular locality. Just as we now have fire watchers and plane spotters, we should have a competent public works corps whose only duty is to make the survey at this time, and whose duty during a bombing is to analyze and see whether the facts upon which they based their survey were true. In this way we shall have a record that will enable us to correct our previous ideas and plan better for a future attack. Many of our assumptions at the present will be found wrong, and we will be able to establish factors in the gigantic laboratory of actual bombing that will be of inestimable value to us for a revision of our tactics and perhaps even give us information for better design in the future. Your Association is the logical source for the initiation of this type of service and information. I believe you should expand the personnel which can be used on this work and that your Association should run schools to train these expanded personnel units in the actual operation during a bombing. You should also explain to them in detail why things are done in the way that you have suggested and give them the pertinent facts upon which your suggestions are based. In this way, if we do have an actual bombing, we shall be relatively safe because it is as true today as any day that forewarned is forearmed; that an emergency ceases to exist when plans for its combat have been prepared.

THE EFFECTS OF WAR GASES ON WATER SUPPLIES: DECONTAMINATION

BY HOWARD H. POTTER*

Introduction. In preparing the program for this meeting, it had been my hope that Mr. C. C. Ruchhoft of Cincinnati, principal chemist of the U. S. Public Health Service, would be available to present this subject to you. My request for his services was answered by the Chief Medical Officer of the Office of Civilian Defense in Washington, by saying that Mr. Ruchhoft was, in addition to being an extremely busy man, engaged on very important research work and had already contributed most generously of his time by lecturing at the War Department Civilian Protection School for Gas Specialists at Amherst. He pointed out to me that I had free access to all of Mr. Ruchhoft's material, and he felt that for that reason I would be as well able to present the subject as would Mr. Ruchhoft himself.

While I appreciate the compliment I hardly agree with it. It should be borne in mind that the paper I am going to give you is a condensation of Mr. Ruchhoft's material and is not, therefore, in any sense to be considered my own personal presentation of the subject.

Any paper on the assigned subject will, to some extent, be obliged to repeat some of the ground covered in the very excellent paper delivered at the September meeting of this Association by Mr. Rubin, but I feel that some outline as to the physical and physiopathological properties of the various chemical agents should be considered before going into the actual effects of these agents on public water supplies. I am, accordingly, going to take up these various properties first with some mention of the methods for the detection of chemical warfare gases before going on to the main subject, and I might add that, realizing that I am talking to water works men perhaps even more than to chemists, I shall try to avoid chemical terms when speaking of the agents and use their common names in so far as it is possible.

The term "war gas" is defined as any chemical agent, solid, liquid

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or gas used in warfare for its toxic or irritant action. There is a large number of compounds possessing suitable physiological properties, but certain other properties limit the gases actually suitable for military use to less than two dozen. The important properties required of a war gas may be listed as follows:

1. Its toxicity should be high, *i.e.*, only a low concentration must be required to produce its poisonous effects.
2. It must be easily manufactured, and the raw materials necessary in its manufacture must be cheap and available in large quantities.
3. The gas must be stable enough so that it will not break down on storage or on explosion of the gas shell in which it is fired.
4. It should be persistent, *i.e.*, remain effective around its point of release for some time.
5. It should be sufficiently noncorrosive toward metals to permit loading and subsequent storage of gas-filled shells. Besides the above properties, the gas should be insidious, *i.e.*, give no discomfort on first exposure, and it should penetrate masks, protective clothing and other means of gas defense. Considering all of these properties, it is easy to understand that out of 3000 compounds investigated prior to 1918 for possible use as war gases, only 25 to 30 were used in actual combat and only about 6 survived to the end of the last war.

Several systems have been devised for classifying the war gases on the basis of physical, chemical, tactical and physiopathological properties. The physiopathological properties are used in the following classification:

1. Vesicants or blister gases include mustard, Lewisite, and ethyl and methyl dichlorarsine. The characteristic action of these substances is to produce blisters on the skin, and they exhibit considerable variation in physical and chemical characteristics, the dichlorarsines being in general less persistent and less stable than mustard gas.
2. Lung injurants or toxic suffocants include chlorine, phosgene, diphosgene, and chlorpicrin. Chlorine, belonging as it does to the bow-and-arrow age of chemical warfare, will be given no more consideration here. These gases all act on the respiratory tract and in general are either true gases or volatile low-boiling liquids. They are non-persistent.
3. Eye irritants or lachrymators include benzyl bromides, bromacetone, brombenzylcyanide, and chloracetophenone. These gases are those having lachrymatory power and are for the most part heavy, oily, and relatively high-boiling liquids, which in the crude state are dark colored owing to decomposition. For the most part they are insoluble in water and very corrosive to metals with the exception of chloracetophenone, which is a white solid and does not corrode metals.
4. The nose irritants or irritant smokes include diphenylchloracene, diphenyl-

cyanarsine, and Adamsite. Under ordinary conditions these are crystaline solids with negligible vapor pressures, and chemically are aromatic arsenic derivatives, practically insoluble in water but readily hydrolized by alkalies and oxidized by oxidizing agents.

The foregoing classification has defects in that certain gases act differently in changing concentrations and that the biological action of these substances is very complex.

General Properties. The important general properties include vapor pressure, volatility and persistence.

Vapor Pressure is the tendency of all substances to pass into the vapor form which causes a certain pressure to be exerted by the vapor produced. This vapor pressure is dependent on the temperature and is usually expressed in millimeters of mercury at a specified temperature. This pressure is of special interest for war gases, as the usual toxic substances, in order to be effective, must vaporize sufficiently to supply enough gas to the atmosphere to produce significant physiopathological results. Especially is this true for the lachrymators, vesicants and lung injurants. In cases of the irritant smokes, the vapor pressure is of minor value as these substances are used in the form of aerosols, *i.e.,* colloidal suspensions in the air. Vapor pressure is a principal factor in the persistence of a gas because the higher the vapor pressure the less the persistence and the shorter the time during which it remains effective at the point of release. The nonpersistent gases, or those having high vapor pressure, vaporize rapidly when released to form a very concentrated and highly toxic cloud, which, however, drifts away with the wind and becomes more or less quickly diluted with the atmosphere. On the other hand, the persistent or low vapor pressure gases, when released, contaminate the surrounding areas with liquid which evaporates slowly and continues to give off dangerous vapors for a comparatively long time. It is the persistent gases that make decontamination procedures necessary.

This distinction has an important bearing on the manner in which the gases are used. Both nonpersistent and persistent gases can be used in shells and bombs; only the nonpersistent can be released as clouds from cylinders and only the persistent as spray from aircraft.

The matter of gas identification is affected by the type of gas. With nonpersistent gases, if the gas officer is not on hand immediately when the concentration is very high, the gas will be dispersed by the

TABLE I—PROPERTIES OF CHEMICAL WARFARE AGENTS

PROPERTY	VESICANTS			LUNG INJURANTS		LACRIMATORS	
Common name	Mustard	Lewisite	Ethyl-dichlor-arsine	Phosgene	Chlorpicrin	Brombenzyl-cyanide	Chlor-aceto-phenone
Chemical name	Dichlor ethyl-sulfide	B-chlor-vinyl Di-chlorarsine	Ethyl-dichlor-arsine	Carbonyl-chloride	Trichlor-nitromethane	Brombenzyl-cyanide	Chlor-aceto-phenone
Symbol (U. S.)	HS	M-1	ED	CG	PS	CA	CN
Melting Point	14°C. 57°F.	—18.2°C. 0°F.	—30°C. —22°F.	—118°C. —190°F.	—69.2°C. —92.4°F.	25°C. 77°F.	59°C. 138°F.
Boiling Point	217°C. 422.6°F.	190°C. 374°F.	156°C. 312°F.	8.2°C. 46.7°F.	112°C. 231.5°F.	225°C. 437°F.	247°C. 476°F.
Vapor Density (Air=1)	5.5	7.1	6.5	3.5	5.6	6.6	5.2
Vapor Pressure (mm. Hg. at 20°C.)	0.065	0.395	5.0	1180	18.3	0.0112	0.013
Volatility (Oz. per 1000 cu. ft.)	0.625	4.5	100	4420	165	0.13	0.106
Lethal Concentration* (Oz. per 1000 cu. ft.)	0.15	0.12	0.50	0.50	2.0	3.5	0.85
Persistency, summer	1-7 days	1-7 days	1-6 hrs.	3-10 min.	1-4 hrs.	3-7 days	10 minutes
Persistency, winter	Several weeks	1 week	2-12 hrs.	20 min. to 2 hours	½-7 days	Several weeks	10 minutes
Solvents For	Oils PS Ethanol CCl_4	HS-PS Oils Ethanol	Ethyl chloride	Cl PS	$CHCl_3$, CG Cl, CS_2 C_6H_6 C_2H_5OH	C_6H_5Cl, $CHCl_3$, PS, CG	$CHCl_3$, PS Ethylene dichloride chlor-acetone

*10-minute exposure.

TABLE 1 (*Continued*)

PROPERTY	IRRITANT SMOKES			SCREENING SMOKES		
Common name	Adamsite	Diphenyl-chlorarsine	Diphenyl-cyanoarsine	HC Mixture	Titanium tetrachloride	Sulfur trioxide solution
Chemical name	Diphenyl-amine chlor-arsine	Diphenyl-chlorarsine	Diphenyl-cyanoarsine	Hexachlor-ethane + Zn+ZnO	Titanium tetrachloride	SO_3+Chlor-Sulfonic Acid
Symbol (U. S.)	DM	DA	CDA	HC	FM	FS
Melting Point	195°C. 387°F.	45°C. 113°F.	31.5°C. 91°F.	184°C. 363°F.	—23°C. — 9°F.	Below —30°C. —22°F.
Boiling Point	410°C. 770°F.	383°C. 720°F.	350°C. 662°F.	185°C. 365°F.	136°C. 277°F.	—— ——
Vapor Density (Air=1)	——	——	——	Negligible	——	——
Vapor Pressure (mm. Hg. at 20°C.)	Negligible	0.0005	0.0001	0.22	8.32	——
Volatility (Oz. per 1000 cu. ft.)	Negligible	0.0007	0.0015	2.85	8.64	——
Lethal Concentration (Oz. per 1000 cu. ft.)	3.0	1.5	1.0	Smoke Harmless		
Persistency, summer	10 minutes	10 minutes	10 minutes	Only while burning	10 minutes	While container is operating
Persistency, winter	10 minutes	10 minutes	10 minutes	Only while burning	10 minutes	While container is operating
Solvents For	Furfural acetone	Acetone $CHCl_3$, PS	Organic Solvents	Alcohol and Ether for hexachlor-ethane	Ethylene dichloride	Strong Sulfuric Acid

*10-minute exposure.

time he arrives. With persistent gases on the other hand, owing to their lowered vapor pressure, the concentration in the air will never be high, but evidence of ground contamination will be encountered for hours or even days afterward under favorable conditions.

Volatility is defined as the weight of the substance contained in a given volume of saturated air at a certain temperature. Our chemical warfare service expresses volatility in ounces per 1000 cubic feet of air, which is nearly equivalent to mg. per liter. It is one of the most important factors in selecting and evaluating a war gas. In the field, it is impossible to reach saturation for the agent, and as a result volatilities as given for the agents in Table 1 may not be obtained. However, a comparison of the volatilities and the lethal concentrations given in Table 1 indicates which agents might be used effectively for producing casualties.

The *persistence* of a gas is affected to some extent by its vapor density, the lighter gases having a greater tendency to rise and be dispersed, whereas the heavier gases tend to hug the ground. The war gases mentioned here vary in vapor density from 2.5 for chlorine to 7.4 for ethyliodoacetate. This latter substance is one of the little used lachrymators or eye irritants which I did not include when enumerating the agents included in that group.

Two of the less important general properties are *freezing point* and *stability*. *Freezing point* is not important except for mustard gas (14.4°C.) and brombenzylcyanide (25.5°C.). These gases are usually diluted with 15 to 20% of carbon tetrachloride or chlorobenzine to lower the freezing point. However, in connection with freezing point, reference should be made to those "war gases" which are really not gases but solids, namely chloracetophenone, with a melting point of 58°C. and the arsenical nose irritants with a melting point ranging from 32°C. to 195°C. The latter substances, in particular, have very little vapor pressure and would be useless as war gases except for the fact that they can be dispersed by heat in the form of a smoke or particulate cloud consisting of very small particles suspended in the atmosphere and capable of exerting an irritant action on the nose and throat. The action is similar with chloracetophenone, although its vapor alone will cause irritation.

These clouds are classified as nonpersistent since they are rapidly

dissipated by the wind as are the true nonpersistent gases. Special types of bombs and thermogenerators have been devised for their employment in warfare. They were originally designed as "mask breakers," the particles not being absorbed by activated charcoal as are vapors but necessitating the use of special filters. This aspect is of importance in their detection; they cannot be satisfactorily sampled by the usual technique of absorption in solvents but require a suitable filter. At the same time they are effective in exceedingly low concentrations and are nonpersistent so that the prospect of obtaining an analyzable sample is usually remote.

Stability—Of the chemical properties, reaction with water is of prime importance, particularly the persistence under wet conditions. Most of the gases are relatively insoluble in water; some, such as chlorpicrin, are practically unaffected by it; others, like mustard gas, are rapidly decomposed. This means that Lewisite would be relatively ineffective in rainy weather and the persistence of mustard gas would be considerably reduced.

From the tactical viewpoint, the stability of gases to heat and explosion and their action on metals are of importance. From the standpoint of defense, the behavior toward neutralizing agents such as alkalies and oxidizing agents is of importance.

Physical and Chemical Properties.

1. Lung Injurants.

a. Phosgene has the chemical warfare symbol C.G. which can possibly be remembered as choking gas. It has the chemical name of carbonyl chloride. At ordinary temperatures, phosgene is a colorless gas with a characteristic odor described as that of mouldy hay. It was first used in war by the Germans in December, 1915, and remained the principal war gas throughout the first World War. While approximately 3½ times as heavy as air due to its high vapor pressure, it is a very nonpersistent gas. My own experience with it in the last war is that in low concentrations it has an odor very similar to that of high explosive powder, and for this reason was used in gas shells which were fired in conjunction with high explosive shelling and caused a large number of casualties due to the fact that its odor was mistaken for that of the high explosive. Phosgene is readily soluble in many

organic solvents and is very soluble in water but is hydrolized with extreme rapidity to carbon dioxide and hydrochloric acid. Like all acid chlorides, phosgene is very reactive especially with alkalies, alcohols, phenols and amines. The reaction with phenols and amines was utilized in the old type P.H. gas helmet which was impregnated with sodium phenate and hexamine. Phosgene is noncorrosive toward metals when dry but extremely corrosive when moist.

b. Diphosgene was one of the principal lethal gases used in the last war and was used principally in shells. Its vapor pressure is high, and so it is a nonpersistent gas, although it is more persistent than chlorine or phosgene. The vapor has an odor similar to phosgene but more pungent. With heat it decomposes to form two molecules of phosgene and reacts with water and amines as if consisting of two molecules of phosgene. When dry it is noncorrosive to metals.

c. Chlorpicrin has the chemical warfare symbol P.S. which may be associated with the name puking stuff. It was known as Klop to the Germans, aquinite to the French, and vomiting gas to the British. It was first used by the Russians in hand grenades and was later employed by the Allies as a constituent of their penetrating N.C. mixture. In its pure state it is a slightly oily, colorless liquid with a characteristic sweetish odor similar to flypaper and has distinct lachrymatory properties. It is relatively insoluble in water but is soluble in organic solvents. It is fairly stable, not being hydrolized by water nor affected by ordinary acids or alkalies. When moist it is corrosive toward metals but produces only a superficial stain which forms a protective layer.

2. Lachrymators.

a. Benzyl bromide was called cyclite by the French and was first used in March, 1915, but only for a short time due to the cost and scarcity of the raw material toluene. Later its use was completely abandoned.

b. Bromacetone is obtained by the brominization of acetone. In its pure state it is a colorless liquid with a pungent odor. It is relatively volatile, and toxic concentrations of its vapor may be met in the field. It is not very stable, although it may be somewhat stabilized with magnesium oxide. It attacks iron but not lead.

c. Brombenzylcyanide has the chemical warfare symbol C.A. and was experimentally tried out toward the end of the last war. According to American post-war experiments it is one of the most efficient war gases because of its high lachrymatory power. When pure, it consists of yellowish white crystals which slowly turn red on decomposition. The odor is that of sour fruit, but the irritation is felt before the odor is noticed. The liquid is very persistent. It is insoluble in water but dissolves easily in many organic solvents. It is highly resistant to chemical and atmospheric agents. Water and humidity decompose it only very slowly. It has the undesirable property of vigorously attacking all the common metals except lead, and in doing so its lachrymatory properties are destroyed. Containers holding this compound must be lined with glass, lead, or rubber. Another limitation is its low stability to the shock of the bursting projectile. It can only be employed in bombs with a comparatively small bursting charge.

d. Chlorocetophenone has the chemical warfare symbol C.N. and was tested during the last war at Edgewood Arsenal. It is a white crystaline solid with a pleasant, aromatic odor resembling that of apple blossoms. As a chemical warfare agent it is dispersed by heat in the form of a nonpersistent particulate cloud. It is practically insoluble in water but is soluble in most organic solvents. Its solubility in readily volatile solvents is utilized in diffusing it into the air. For this purpose benzine is best, carbon tetrachloride also being employed occasionally. When a solution in one of these solvents is sprayed into the air, the solvent rapidly evaporates, leaving the chlorocetophenone dispersed in a fine state of subdivision. It is very effective when distilled into the air by the heat of a burning composition, such as a mixture of C.N. with a small-grained smokeless powder. It is stable, unaffected by boiling water, but the chlorine is readily removed by alkaline hydrolysis. It does not attack iron and is insensitive to heat and detonation.

3. Nose Irritants.

The action of these compounds of an aromatic arsenical nature is provoked by finely divided solid particles which on liberation in the air form true smokes and are known as the toxic smokes. They were intended as mask breakers but were not very successful because their use in modified high-explosive shells did not give a good particulate

cloud. When released as a cloud from smoke candles they are very effective. Under ordinary conditions they are crystaline solids with negligible vapor pressure.

a. Diphenylchlorarsine has the chemical warfare symbol D.S. The crude material is a dark brown liquid which gradually turns into a semi-solid viscous mass. It is only slightly soluble in water but is soluble in some organic solvents. Water hydrolizes it very slowly. It is insensitive to heat and detonation and does not corrode iron or steel.

b. Diphenylcyanarsine has the chemical warfare symbol C.D.A. It was employed as a war gas toward the end of the last war both alone and mixed with diphenylchlorarsine. It has an odor of mixed garlic and bitter almonds. It is sparingly soluble in water but dissolves in some organic solvents. Its properties are similar to those of the chlor derivatives, being employed in the same manner but effective in a lower concentration.

c. Adamsite has the chemical warfare symbol D.M. In the crude state it is a crystaline solid, the pure product being yellow and odorless. It is practically insoluble in water and sparingly soluble in common organic solvents. Unlike the two previous arsines mentioned, it is slowly hydrolized by water, readily hydrolized by alkalies and oxidized by oxidizing agents. Iron, steel, bronze, and copper are corroded by this compound.

4. Vesicants.

a. Mustard gas has the chemical warfare symbol H.S. It was first employed by the Germans in July, 1917. In the pure state it is a colorless, oily liquid, but in the crude state it is brown and has an odor reminiscent of mustard, garlic, or horseradish. Its vapor pressure is 0.115 at 20°C. with a vapor density of 5.4, so that it is very persistent, especially on terrain covered with bushes and shrubs. It is the chief member of the vesicant group and was the only one used during the last war, although the potentialities of Lewisite and other dichlorarsines were being investigated. Mustard together with Lewisite and the other dichlorarsines all show considerable variation in the physical and chemical properties, but they all possess the common characteristic of being able to penetrate into and destroy all living tissues that they contact. Mustard is sparingly soluble in water, in which it sinks. It

is slowly hydrolized to give harmless water-soluble products. The following values have been determined for the hydrolysis of mustard gas.

Time (Minutes)	*Per cent hydrolized compared to that dissolved*
10	50
20	70
30	79
40	84
50	85
60	85

The velocity is influence by time of contact, temperature, water-mustard gas ratio, quantities of acid, alkali and hydrolysis products present and the degree of dispersion in water. In the presence of a large excess of water the conversion is quantitative.

Dry chloride of lime reacts with mustard gas, acting as an oxidant and chlorinating agent. A very violent reaction, with evolution of heat, flame and white vapors, takes place. Numerous compounds are formed, carbon dioxide, hydrochloric acid, chloral and chlorinated substances which are not defined. By the action of chloride of lime mixed with water, the action is less violent, and this type of mixture is employed for decontamination of objects contaminated with mustard gas. This action of the bleaching powder depends on its available chlorine, and the bleach should contain at least 15% of active chlorine.

The pure liquid does not attack metals under ordinary conditions but the technical product usually contains free hydrochloric acid and has a marked corrosive action on iron and steel.

b. Lewisite, having the chemical warfare symbol M-1, was developed as a war gas by the Americans during the last war but was never used in the field. It has been termed the "Dew of Death" and is claimed to embody the aggressive qualities of the asphyxiants, the irritant characteristics of the tear and nose irritant gases, and the universal action on all tissues of the blister gases. When pure, Lewisite is a colorless liquid with a vapor pressure of 0.4 which makes it less persistent than mustard. The vapor of the pure compound has an irritant action on the eyes and nose. The technical product, which is usually black, has an intolerable geranium-like odor, perceptible even in

great dilution. It is sparingly soluble in water but readily soluble in organic solvents. It is rapidly hydrolized by water into hydrochloric acid and, to give it its full name, chlorvinyl arsenious oxide. This oxide is somewhat vesicant for direct contact but is much less dangerous than Lewisite because it is nonvolatile and sparingly soluble in water and other solvents. Lewisite is very reactive, being readily oxidized and chlorinated. It does not attack steel appreciably and when stored in projectiles causes only a slight superficial rusting of the metal walls.

c. Ethyl dichlorarsine has the chemical warfare symbol E.D. and was employed in March, 1918 by the Germans, it being considered suitable as a replacement for mustard gas in offensive operations because of its immediate vesicant effect and its nonpersistent character. It has a fruity odor in dilution which can be detected in very low concentrations. It is readily soluble in organic solvents but is very slightly soluble in water. Water rapidly hydrolizes ethyl dichlorarsine, and it is decomposed readily by bleaching powder which is used in decontamination. When dry it does not attack iron but corrodes brass strongly.

Detection. The detection of the presence of war gases along with their identification plays a very important role in defense. There are two principal methods that may be called the subjective and objective. Because the objective method involves the use of chemical methods, we shall consider only the subjective, leaving the objective to the duly appointed gas officers and gas reconnaissance agents, who, for the most part, will be trained chemists and will have the requisite laboratory facilities.

In case of attack, it is vital to know quickly the nature of the gas used and the extent of the areas affected. For this reason, the methods for the detection of gases should possess the following properties:

First, the results should be accurate and readily obtainable, and second, the methods should be reasonably specific.

The British have a field kit that contains simple apparatus for the detection of mustard gas and equipment for taking contaminated samples of material for subsequent examination. While I am not personally familiar with this British field kit, the Chemical Warfare Service of the United States Army also has in production a field kit for the detection of mustard gas which is easily operated. There are also

detector papers. While these detector kits and papers really fall within the objective method of detection rather than the subjective, should they ever become available for more or less general use their operation is so simple that they could be used by anyone regardless of whether or not he had any great knowledge of chemistry.

In the case of nonpersistent gases and particulate clouds, little action is possible unless the gas officer is present at the time of the release; otherwise, by the time of arrival the gas is too dilute for identification. With bombs containing less volatile but still nonpersistent lung injurants such as diphosgene and chlorpicrin, it will usually be possible to detect the gas in the earth surrounding the bomb crater for hours afterwards.

Of the persistent gases, the persistent lachrymators are identified by lachrymation. Vesicants, on the other hand, particularly mustard, are the main reason for the gas identification service in Britain. Rapid detection of the blister gases is essential to avoid spreading the contamination from the gas bomb and to enable prompt decontamination measures to be started.

Subjective tests include smell, appearance, and physiological action. For speedy recognition in the field, the subjective tests are very rapid and are normally of great value. Considering them in order, we will take up first, smell.

Smell. Many of the war gases have definite odors that can be detected in relatively harmless concentrations. Crude mustard gas can be detected by smell in a concentration of 1 in 20,000,000 (approximately 0.35 mg. per cu. m. of air), and the geranium-like odor of Lewisite can be detected in even greater dilutions.

The sense of smell has certain limitations. It is liable to be erratic, subject to personal idiosyncrasy and individual variation in different individuals, and from time to time in the same individual.

In spite of the objections noted in the preceding paragraph, the sense of smell is very useful and can be developed by practice with odor kits. These are a collection of samples of war gases suitably contained (usually absorbed on activated carbon in a bottle) by which one may thoroughly acquaint himself with the characteristic odors of certain war gases.

Certain rules should be followed in making odor tests:

1. Don't inhale deeply.
2. Smell only once; repeated smelling dulls perception.
3. First smell and then think; the ability to recall smells can be acquired by practice.
4. After smelling breathe out strongly through the nose several times.
5. Don't smoke while smelling; smoking dulls the sense of smell. Even slight traces of phosgene affect the taste nerves so that tobacco smoke acquires a flat, metallic taste and becomes disagreeable and repugnant. Hydrocyanic acid and hydrogen sulfide have the same reaction to a less degree.
6. Name each odor perception. A gas is odorless only when no odor is evident. In the event of an unfamiliar smell, it is important that the description of the odor be accurate and comprehensive.

Smell tests in the field should be made downwind, *when wearing a respirator,* by turning the back of the head to the wind and inserting the fingers between the facepiece and the cheek and sniffing gently. The tendency of gases and vapors to rise as they drift downwind should also be borne in mind, and care should be taken to make smell tests close to the ground when endeavoring to locate the source of contamination.

Sight. The sense of sight is of importance in the recognition of persistent gases. Certain cases of nonpersistent gas may be mentioned; *e.g.,* a concentrated cloud of chlorine has the characteristic yellow green color of this element unless there is much moisture in the atmosphere, when it appears whitish owing to condensation. Phosgene and disphosgene similarly give whitish clouds under damp conditions but are invisible when dry; particulate arsenic "smokes" are white and opaque if sufficiently concentrated. A white cloud does not always indicate poison gas; it may be screening smoke or smoke arising from use of incendiary or other bombs.

In general, the nonpersistent gases will have been dissipated before the gas officers arrive, leaving a certain amount of residual evidence in the form of rotted clothing and bleached vegetation, or corroded metal, particularly copper and copper alloys (notably with the lung irritants in damp weather). The size of the bomb crater may indicate gas, as craters produced by high explosive bombs are usually considerably deeper and more extensive than those from gas bombs.

With the persistent gases on the other hand, and mustard gas in particular, sight may or may not afford a reliable indication according

to circumstances, but contamination of grounds and buildings with the liquid gas will invariably occur and afford visual evidence.

Contamination by crude mustard gas, which has a black color, is somewhat easier to detect than that of the pure pale yellow product, although the stains have the same appearance other than their color. On dry porous surfaces the liquid is rapidly absorbed, leaving a dark oily stain. On dry roads and dry earth it also appears as a dark oily patch, while on wet surfaces it spreads and gives a slightly iridescent effect. It remains as liquid drops and splashes on painted surfaces for a considerable time although it eventually softens and dissolves in the film. It does not penetrate into metals, glazed tiles and other impermeable materials and also remains in droplet form on green foliage and grass for some time, eventually penetrating and damaging vegetation. In water, the bulk settles to the bottom, but a thin and somewhat iridescent film usually remains on the surface for some time.

The indications here noted are applicable to the immediate vicinity of the bomb crater. Lighter contamination further away and resulting from aerial spray takes the form of very small pinpoint droplets and is harder to see.

The crude blister gases are similar in appearance to the persistent lachrymators (both dark colored oils), and the two may be confused. Periodic smelling tests should be made to avoid this confusion.

Physiological Effects. Physiological action forms a valuable adjunct in the identification of some gases. Lachrymators are readily recognized by their immediate irritant effects on the eyes even in low concentrations (1 in 20 to 30 million). Similarly the nose irritants give rise to their characteristic, though slightly delayed, irritation of the nose, throat and chest even in low concentrations. With those smokes which are practically odorless in such dilutions, physiological detection becomes the only practicable field method.

Of the lung irritants, chloropicrin has lachrymatory effects in relatively low concentrations and like chlorine is intolerable to breathe in concentrations that are relatively harmless. With phosgene and diphosgene, on the other hand, the irritant effects are far less marked, and concentrations that are just detectable by smell and slight irritation of the breathing passages are not intolerable to breathe, but they may lead to serious results if breathed for any length of time. Further,

the intensity of physiological effects affords little indication of the concentration present. To wait for physiological indications in the case of such gases is inviting disaster.

Similar remarks apply especially to mustard gas, which has a characteristic delayed action and produces no immediately recognizable symptoms. The arsenical vesicants, Lewisite, etc., have an immediate irritant effect on the nose and eyes, which can serve as a warning indication.

The use of test animals is of value in certain circumstances but has obvious limitations and is not suitable for general war application.

Chemical Agents and Public Water Supplies. The possibility of contamination of our water supplies by war gases is open to the same arguments, *pro* and *con,* as the possibility of gasing civilian populations. These actions probably would not be attempted, except against untrained civilians. Heretofore, the only poisoning of water supplies by poison gas was accidental.

Protection of our water supplies in reservoirs depends on the increasing vigilance of our waterworks personnel. Systems for guarding our waterworks against trespassers or possible saboteurs have, in most cases, already been put into operation. In a similar manner we must be on the alert to protect against any poisoning by war gases and to have a plan of action, should contamination occur.

It might be said that the results obtained by an enemy in poisoning our water supply probably would not equal the effect caused by the same weight of high explosive or incendiary bombs, but this is pure speculation. We must consider the possibility of accidental or deliberate contamination during a gas attack on a city, especially if the element of surprise is present. It should be emphasized that the success or failure of such an attack depends as much on our advance preparations as on the skill of the enemy.

The chemical warfare agents may be divided into a number of groups, according to their effectiveness in producing toxic contamination of water supplies. This classification is given in Table 2. Group 1 in this table includes thermit, crude oil, FS mixture, FM and carbon monoxide, all of which would not produce a toxic water, although the taste and odor might be accentuated to produce an unpleasant water that might not be potable. Group 2 includes the arsenical irritant

TABLE 2—CLASSIFICATION OF CHEMICAL AGENTS UPON BASIS OF TOXICITY TO WATER

Group 1	Agents probably will produce a non-toxic water, though it may be non-potable.	Thermit, crude oil FS Mixture HC Mixture Titanium tetrachloride Carbon Monoxide	 FM
Group 2	Agents producing a turbid water that is non-toxic after removal of the turbidity.	Adamsite Diphenylchlorarsine Diphenylcyanoarsine	DM DA CDA
Group 3	Agents present in fairly high concentrations that would produce a non-toxic water.	Phosgene	CG
Group 4	Agents likely to cause trouble in a water supply unless extra precautions are taken.	Chlorpicrin Mustard Lewisite Ethyldichlorarsine	PS HS M-1 ED
Group 5	Agents requiring additional data for definite classification.	Brombenzylcyanide Chloracetophenone CN Solution	CA CN CNS
Group 6	Compounds only likely to be used for deliberate contamination.	Arsenates, Arsenites Cyanides Heavy metal salts Alkaloids and toxins Pathogenic Bacteria	

smokes such as Adamsite and diphenylchlorarsine. These substances are insoluble and stable in water. Consequently, if the sources of supply were contaminated with these agents, the standard water purification processes, including coagulation, settling, filtration and chlorination would remove them and produce a safe potable water. Group 3 includes phosgene which might be present in considerable concentration and would still result in a non-toxic water. Group 4 contains the vesicants and chlorpicrin, the presence of which would cause the greatest difficulty in water supplies. Brombenzylcyanide and chloracetophenone are put into Group 5 because few data are available on their effects in water supplies. More information on the reactions and effects of these agents in water is needed. Compounds other than chemical warfare agents which are likely to be used for deliberate contamination of water supplies are listed in Group 6.

To show the basis for this grouping of the chemical warfare agents, the solubility, behavior and products of hydrolysis of the more important agents are shown in Table 3. The treatment ordinarily required for water that has been contaminated by these agents is shown in the right-hand column.

TABLE 3—CHEMICAL BEHAVIOR OF AGENTS TO WATER

	AGENT		SOLUBILITY MG. PER LITER AT 20°C.	BEHAVIOR	PRODUCTS OF HYDROLYSIS	TREATMENT REQUIRED[3]
Vesicants	Mustard	HS	800	Slowly hydrolyzed[1]	HCl and thioglycol (non-toxic)	Treatment for removal difficult.[2]
	Lewisite	M-1	500	Rapidly hydrolized	HCl and ClC_2H_2AsO (toxic, sparingly soluble)	May be used for period of week or less if 10 p.p.m. are present.
	Ethyldichlorarsine	ED	Very soluble	Rapidly hydrolized	HCl and C_2H_5AsO (toxic, soluble)	With higher concentrations pump to waste.
Lung Injurants	Chlorpicrin	PS	1700	Stable	——	——
	Phosgene	CG	1000	Rapidly hydrolized	HCl and CO_2	Neutralization if pH indicates it, otherwise no treatment.
Lacrimators	Brombenzylcyanide	CA	Insoluble	Stable	——	Probably coagulation and filtration is all that would be required.
	Chloracetophenone	CN	Insoluble	Stable	——	
Irritant Smokes	Adamsite	DM	Insoluble	Stable	——	
	Diphenylchlorarsine	DA	Very slightly soluble	Slowly hydrolized	KCl and $(Ph_2As)_2O$	Coagulation and filtration.
	Diphenylcyanoarsine	CDA	Insoluble	Stable		
Screening Smokes	HC mixture	HC	——	C_2Cl_6 slowly hydrolized		Neutralization with $CaCO_3$ or lime, if pH indicates it, otherwise no treatment required.
	SO_3 in $HClSO_3$	FS	Very soluble	Rapid reaction	H_2SO_4 and HCl	
	Titanium Tetrachloride	FM	Soluble	Hydrolized	HCl and Ti $(OH)_4$	
Systemic Poison	Hydrocyanic acid		Very soluble	Slowly decomposed	Ammonium formate and brown polymeric products	Ferrous, ferric salt treatment followed by coagulation and filtration.

[1]Eighty-five per cent of solute hydrolized within one hour.

[2]Best treatment involves use of high doses of activated carbon followed by coagulation and filtration followed by chlorination to beyond the break-point. If chlorine demand of treated water is over 5 p.p.m. water is unsatisfactory. For small doses (50 p.p.m. or less) of mustard, wait one hour and then take water from intermediate level for purification. Water containing 500 p.p.m. or more is not satisfactory for treatment.

[3]Standard disinfection practice with chlorine should be understood to follow all water treatment suggestions.

Mustard gas, which is likely to give trouble in water supplies, is soluble to the extent of 800 p.p.m. at 20°C. When discharged into water, the mustard gas is distributed into a surface film and a water soluble fraction, and any excess present settles to the bottom. The undissolved mustard may remain unchanged for several weeks at the

bottom of the water. The soluble fraction is hydrolized to hydrochloric acid and thiodiglycol. This latter is soluble in water and is non-toxic. The rate of hydrolysis depends upon the quantity of gas present, the temperature and the alkalinity of the water. Boiling destroys mustard in 15 to 30 minutes, but 2 or 3 days are required if storage at ordinary temperature is used.

The armed services of our country consider water containing 500 p.p.m. or more of mustard as impossible to treat for drinking purposes. With less than 500 p.p.m. the water may be treated if the following procedures can be employed. Treatment with unusually large doses of activated carbon followed by coagulation with the common chemicals and settling. The settled water is then filtered and chlorinated beyond the break-point. However, if the filtered water has a 5-minute chlorine demand of more than 5 p.p.m. the water is still unsatisfactory and must be re-treated. For small doses of mustard (50 p.p.m. or less), the hydrolysis reaction will be sufficiently complete after one hour to permit use of the water from intermediate reservoir levels. Where other sources of water are available, finished water reservoirs should be pumped to waste if contaminated with mustard gas to any extent.

Water contamination by Lewisite, ethyl dichlorarsine or methyl-dichlorarsine would also give trouble. Lewisite is the least soluble of these gases, but all of them are rapidly hydrolized. The chlorvinyl and ethyl and methyl arsenious oxide hydrolysis products are all sufficiently soluble to be dangerous in a water supply. These soluble arsenious oxides cannot be removed by ordinary water purification processes. Consequently, the extent of the contamination should be determined by complete sampling and careful analytical procedures for arsenicals. If the arsenic content does not exceed 1 to 5 p.p.m., the water would be safe to use for periods varying from one day for the higher concentration to one week for the lower concentration. If larger quantities of arsenic are found, or if other non-contaminated supplies are available, the water should be pumped to waste. These suggested limits for arsenic under emergency conditions are very much higher than the arsenic limit in the latest Public Health Service Drinking Water Standard (0.1 p.p.m.). The Public Health Service limit applies to waters that may be used continuously, while the limits suggested here apply under emergency conditions to supplies that are to be used only for periods of one week or less.

The last of the gases in group 4 that is likely to give trouble in water is chlorpicrin. Chlorpicirin is slowly soluble to the extent of 1700 p.p.m., is very stable, and is not hydrolized by water. If a water supply is heavily contaminated with it, most of the chlorpicrin will settle to the bottom of the reservoir, after which it will slowly go into solution. Ordinary water treatment processes are ineffective in its removal. Once the chlorpicrin is dissolved in the water, excessive doses of activated carbon could not be relied upon to remove it. It can best be detected by its characteristic sweetish odor in concentrations down to as little as 5 p.p.m. in water. Its odor and taste are easily noticeable at 10 to 20 p.p.m. A concentration of 40 p.p.m. gives a burning sensation to the tongue within a few seconds, and might be considered beyond the limit of potability. Water containing 80 p.p.m. or more will produce lacrimation. The odor and taste indications of chlorpicrin in a water can be confirmed by the nitrite test after boiling a small sample of the water with alcoholic potassium iodide to decompose the gas. It is suggested that 20 p.p.m. be taken as the upper limit of potability for chlorpicrin. Waters containing quantities of 100 p.p.m. or more might be made potable by aeration for several hours or by storage in open reservoirs for 1 or 2 days. Additional experimental work is needed to determine more exactly the upper limit of safety for chlorpicrin and possible treatment procedures for its removal.

The lung injurant, phosgene, is soluble to the extent of 1000 p.p.m. in water and is rapidly hydrolized to HCl and CO_2. Consequently, no toxicity is produced with phosgene contamination after hydrolysis is completed. If the pH of a water is lowered to the extent that it is unpleasant to the taste, this can be easily adjusted with lime.

The lacrimators, brombenzylcyanide, and chloracetophenone have been put in Group 5, for which additional information is required. These agents are considered insoluble and stable by all authorities. Consequently, they would be largely removed from raw waters by complete water purification processes. The extent to which they could be permitted in treated waters remains to be determined.

The irritant smokes, including Adamsite, diphenylchlorarsine, and diphenylcyanarsine, are either insoluble and stable or very slightly soluble and slowly hydrolized. These arsenical agents would, therefore, produce a turbid water which could be purified by the complete water

treatment processes. If contamination with these agents is suspected in clear-water reservoirs, samples of the water should be examined for chlorine demand and arsenic, and the limits for arsenic already suggested for Lewisite should not be exceeded. If additional water supplies are easily available, contaminated reservoirs should be pumped to waste even if they contain arsenic in concentrations within the stated limits.

The screening smokes do not produce toxic products and need give little concern. Although adjustment of the pH may be necessary with heavy contamination of these agents, no other treatment will be required. While titanium hydroxide will be formed by the hydrolysis of titanium tetrachloride (FM), there is no evidence that this material is toxic. Titanium salts have, in fact, been suggested for use as coagulants in water purification.

The possibility of the introduction of cyanide by saboteurs or by hydrogen cyanide bombs, should not be overlooked. Simple tests for cyanide in water are available and should be made if cyanide contamination is suspected. Finished waters should be pumped to waste if cyanide is found. In raw waters the cyanide can be removed by treatment of the neutral or alkaline water with ferrous and ferric salts, followed by the standard water purification processes. This treatment would precipitate the cyanide as Prussian blue, most of which would then be removed by coagulation and filtration. As long as an excess of iron salts is used, any blue color coming through the filter would be non-toxic.

Detection of Contamination by Chemical Warfare Agents. An examination of Table 3 indicates that all of the troublesome chemical warfare agents with the exception of chlorpicrin hydrolize with the production of acid; most of them contain arsenic and all of them increase the organic constituents of the water which would increase its oxygen-consumed and chlorine-demand value. Procedures to determine changes in the following criteria may be employed to detect contamination: (1) *odor and appearance, including turbidity,* (2) *pH,* (3) *chlorine demand,* (4) alkalinity, (5) chloride content, (6) oxygen consumed, (7) presence of arsenic.

In devising a plan of action, it should be remembered that scientific personnel may not be on hand at all waterworks, and the plan of detection should be arranged so that the tests will be as simple as

possible to enable persons with the minimum of training to carry them out. The simple criteria just previously given, especially the first three, will probably suffice to indicate to an alert observer whether or not a gas warfare contaminant is present. The interpretation of the tests will be easier if a complete record of these criteria is kept from day to day. Most of these methods are capable of giving rapid results and are, therefore, as important as tests for any specific material.

In attacks with the vesicant gases, the same precautions must be observed by the waterworks personnel as by any other person in an area gased with persistent vesicants. If the banks or the walls of the reservoir have been sprayed with these gases, protective clothing and gas masks will have to be worn even to sample the area to avoid injuries. Unless this protection is available, the work of detection should be left to the gas officer. The detection of war gases and decontamination of any areas in the waterworks property which may be affected should be one of the first, if not the first, jobs to be undertaken after a gas attack. Following this or simultaneously, if possible, the rapid tests for contamination of the water should be made to determine the extent of contamination, so that an immediate decision can be reached regarding cutting off the flow of water from a finished-water reservoir or initiation of emergency purification procedures.

Although most of the rapid tests that have been given in this paper are familiar to waterworks men, I am giving a short discussion of the first three, because these three can probably be made by almost any waterworks man who is equipped with a colorimetric comparator of the Hellige type. The remaining four tests require laboratory facilities and well trained laboratory personnel. It is my feeling that any great deviation from normal in the first three tests is sufficient indication that something is wrong. Use of the water should then be immediately discontinued and samples submitted to the nearest laboratory for further study according to the remaining four tests.

(1) Odor and appearance can be used to detect and identify some of the gases in contaminated water. The odor of mustard (HS) and Lewisite (M-1) can be detected in many waters contaminated with 500 p.p.m. or more of these gases. In concentrations of 100 p.p.m. these gases cannot be detected. As already stated, chlorpicrin can be detected in concentrations as low as 5 p.p.m. by odor. Most of the war gases

are heavier than water and if dropped into a reservoir will sink to the bottom, but they may leave a thin film on the surface of the water or they may give an insoluble hydrolysis product which may be detected. The white chlorovinylarsenious oxide is formed immediately upon contact of Lewisite with water and rapidly settles to the bottom. Crude mustard looks like dirty crank case oil, and this gas leaves a surface film that may remain for 24 to 48 hours. Solid particles on the water surface may be chloracetophenone or one of the irritant smokes. These gases are considered stable and insoluble and may be detected by increases in the turbidity.

(2) An unusual lowering of the pH will indicate an acid hydrolysis product. Most waterworks laboratories are equipped with some apparatus to make these determinations which may be electrometric or colorimetric. The colorimetric comparator already mentioned is portable and simple to use. Its use may be taught to one with little training in a short time. Among the gases that lower the pH by hydrolysis with the formation of a halogen acid are: mustard, Lewisite, phosgene, diphosgene, ethyl dichlorarsine, methyl dichlorarsine, diphenylchlorarsine, and possibly brombenzylcyanide.

(3) Considering first those public water supplies that use chlorine for sterilization, it is very simple to determine any great deviation from normal in the chlorine demand. The approximate amount of chlorine per 24 hours required to give a certain stated residual is very well known. If it is found that this amount does not give the required residual and probably shows no color whatever, and it is necessary to step up the chlorine dosage considerably before any color is detected, this fact in itself is a clear indication that the demand for chlorine in the water has materially increased. Most of the war gases react with chlorine and may be detected by routine determinations of chlorine demand. Where the water to be tested contains more than 0.3 p.p.m. of iron, 0.01 p.p.m. of manganese, or 0.3 p.p.m. of nitrite, the starch iodide procedure must be used.

For water supplies that are not normally using chlorine for sterilization, or where a more complete laboratory test seems desirable, it may be well to briefly outline a more positive method of determining chlorine demand. The reagents necessary for this test are the orthotolidin solution and chlorine water. For complete information as to

how these reagents are prepared, reference is made to "Standard Methods of Water Analysis" 8th edition, American Public Health Association. The procedure to be employed follows:

To a 250-ml. sample add the standard chlorine water 0.5 ml. at a time with gentle stirring until a spot plate test, using 1 drop of orthotolidin solution and 0.25 ml. of sample, gives a yellow color. Call this the immediate chlorine demand.

On the basis of the immediate chlorine demand take a new sample of smaller size, if more convenient, and add the proportionate total amount of chlorine solution added in the immediate determination, plus 0.1 to 0.2 ml. in addition. Stir gently and in exactly 5 minutes test a portion of the sample for residual chlorine according to standard method. Repeat this procedure until 0.1 p.p.m. residual chlorine is obtained after 5 minutes of contact.

When 250 ml. of sample are used, the p.p.m. of chlorine demand equals mililiters of chlorine solution times miligrams of chlorine per mililiter times 4. If more than 0.1 p.p.m. of residual chlorine is found after 5 minutes of contact, an approximate value of the defined chlorine demand (if 250 ml. of sample were used) is equal to mililiters of chlorine solution, times miligrams of chlorine per mililiter, times 4, plus 0.1, minus the residual chlorine found in p.p.m. The chlorine demand may be used as a standard of potability. For this purpose, standard chlorine water may be used directly on the sample. Using this procedure the chlorine demand of a potable water should not exceed 5 p.p.m. The only interfering substance for this test is hydrogen sulfide. If the odor indicates hydrogen sulfide, it may be removed by aerating the acidified water sample for a few minutes before the chlorine-demand test is made.

A chlorine demand obtained in a clear water may indicate contamination by mustard, Lewisite, ethyl dichlorarsine or methyl dichlorarsine. For the determination of these contaminants, no adjustment of the pH is necessary.

A chlorine demand in turbid waters may indicate diphenylchlorarsine, diphenylcyanoarsine or Adamsite along with the above gases.

As already stated, I am not going into the tests for alkalinity, chlorine content, oxygen consumed or arsenic for the reason that the chemists who are hearing me will already know how to make those

TABLE 4—IDENTIFICATION OF COMMON CHEMICAL AGENTS BY ODOR AND OTHER IMMEDIATE EFFECTS

CLASS	AGENT	SYMBOL	ODOR		OTHER IMMEDIATE EFFECTS	
			CHARACTER	THRESHOLD MG. PER CU. METER	NATURE	THRESHOLD OF ACTION MG. PER CU. METER
Vesicants	Mustard	HS	Garlic, horseradish	0.3	None	——
	Lewisite	M-1	Geraniums	1	Nose and throat irritation	2
	Ethyl-dichlorarsine	ED	Fruity, pungent irritant	0.8	Nose and eye irritation	1.5
Lung Injurants	Phosgene	CG	Musty hay, cut corn, silage	5-10	Thin white cloud produced coughing, tightness in chest	10-15
	Chlorpicrin	PS	Sweetish, fly-paper, like licorice	8	Lacrimation, vomiting	15-20
Lacrimators	Brombenzyl-cyanide	CA	Sour fruit (Irritates before odor is noticed)	0.2	Lacrimation, nose irritation	.2
	Chlor-acetephenone	CN	Locust or apple blossoms		Lacrimation	.3
	CN Solution	CNS	Sweetish	——	Skin irritation	2
					Skin irritation	
Irritant Smokes	Adamsite	DM	Odor from burning smokeless powder	——	Canary yellow smoke, headache, vomiting	0.1
	Diphenyl-chlorarsine	DA	Aromatic, irritant	0.3	Sneezing, headache, vomiting	0.1
Screening Smokes	HC Mixture	HC	Smoky, camphor like	——	Dense smoke, slight suffocating feeling	——
	SO_3 in $HClSO_3$	FS	Acid (strong)	——	Dense smoke, eye irritation, prickly sensation on skin	——
	Titanium tetrachloride	FM	Acid (mild)	——	Slight eye irritation, dense smoke	——
Systemic Poisons	Hydrocyanic acid	——	Bitter almonds	1.0	Headache, dizziness, collapse	20
	Carbon monoxide	——	None	——	Headache, collapse	——

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	Carbon monoxide	——	None	——		

tests and waterworks operators who are not chemists have little interest in the matter. The first three tests alone are sufficient to show any unusual condition needing further examination. If further analysis is necessary, samples should be collected and sent immediately to the nearest available laboratory.

THE FBI WAR INVESTIGATIVE JURISDICTION

BY JOHN T. MADIGAN*

Ever since 1908, when the FBI came into existence, it has been known as a criminal investigative agency. We worked on hijacking cases, bank robberies, kidnapping, and crimes on the high seas, interstate fugitive cases, felonies on government reservations, antitrust violations, bankruptcy violations, and so on; but in September of 1939 the FBI also added to its responsibility the work of sabotage, espionage, and subversive activities investigations. One day in 1939, shortly after the President of the United States had declared this country was in a state of emergency, he called upon three national investigative agencies —the Office of Naval Intelligence, the Office of Military Intelligence, and the FBI—and divided among those three organizations all of the National Security investigative work. To the Office of Naval Intelligence he gave the job of handling investigations of its own personnel. Enlisted men or officers of the Navy charged with or suspected of being engaged in subversive activities or espionage would be investigated by Naval Intelligence. They also were given the job of handling investigations in their own establishments and bases. Military Intelligence was given the same jurisdiction in respect to their facilities. The FBI was given the investigation of all sabotage, espionage, and subversive activities, with the exception of cases involving military personnel or bases. The sabotage investigative jurisdiction of the FBI includes all private plants in the country, even if they have 100% contracts with Army or Navy.

Back in the days when the announcement was first made that citizens should turn in complaints to the FBI, plant officials in this country, who were manufacturing material for the British military machine and for our own military needs, reported hundreds of complaints. I think you will remember that there was a lot of talk about sabotage in those days. As a result, when plant officials were asked by the President to turn over information of possible sabotage in their

*Special Agent in Charge, Boston, Mass.

plants to the FBI, our offices went into action. In one day alone in 1939, there were close to thirty-five hundred complaints which poured into our fifty-six offices throughout the country. We immediately enlisted the assistance of the police all over the country. Four times a year, thousands of police heads gather at FBI Conferences under our police mobilization plan. Law enforcement, three years ago, was ready for war.

Since 1939, there have been over two hundred individuals convicted of sabotage, who are presently serving terms in Federal penitentiaries. That includes men who had a gripe against the company, who damaged machines turning out war items. It includes the man who had a gripe against his fellow employee and in order to make him look bad damaged the product he was manufacturing. Of those cases, none has been of the type that we might consider foreign-directed or foreign-organized. From 1939 to the present time, our Director, J. Edgar Hoover, has not seen a scrap of evidence, during all cases and incidents that have been investigated, of any foreign-directed ring or group of conspirators to sabotage our plants and our industries on a general plan.

There has been one exception and that one exception was on June 13 and 17. On June 13 four men, Germans, but American naturalized citizens, came from Germany, by submarine, and were landed off the coast of Long Island, at Amagansett. When they landed, they wore German marine uniforms, and they had with them four big wooden cases. The marine uniforms were worn by them because the German plan was that if they were caught when they were put ashore they would be treated as prisoners of war instead of espionage agents. When they got on shore, their instructions were to bury their uniforms if they were not accosted, bury the cases, and proceed with a preconceived plan of knocking out the aluminum industry, or a part of it. A group also landed near Jacksonville, with four in the party. They were dressed in bathing suits and German marine caps. The caps were placed on them for the same purpose, that, assuming they had a German cap, they would be treated as prisoners of war. They were instructed to transfer into civilian clothes if not accosted, and they in turn had wooden cases with them. They had with them a lot of material.

Because of Presidential request, the records and evidence in this

case have been sealed until the end of the war and so, honoring the request of the President and the military authorities, I can't speak about the procedure or the investigative procedure of the cases. But on June 23, the men were caught. Six were electrocuted and two were given prison terms. The material they had with them was a matter of great interest. It ranged from explosives, detonating devices, fuses, to time devices very cleverly made up, and very expensive.

In connection with espionage, you have read in the past year probably about the rings that have been broken up by the FBI and prosecuted successfully. These espionage investigations are not as simple as the ordinary criminal investigation where you may get a complaint one week and by the end of the week you have the case ready for the District Attorney, and the following week it is presented to the Grand Jury, and within twenty days or so you have a conviction. It is not as simple as that. A typical example is what we term the New York Spy Case. Several years ago William Sebold came from Germany to this country and, after residing here for the required time, he became a naturalized citizen, taking the oath of allegiance. He got a job in an aircraft plant. He had a number of relatives in Germany, and in 1939 he went back to visit them and while there, he was contacted by some representatives of the Nazi party, who tried to interest him in a proposition that, when he returned to his old job in the aircraft factory, he would from time to time turn over any information that might be of advantage to the German espionage system. He turned that proposition down flatly, because apparently when he took the oath of allegiance to this country, he meant it. But he was contacted again and again; finally they used the pressure system, and they told him that it would go badly with his folks over there, that they would probably find themselves in a concentration camp if he did not comply with their wishes, so that he had to agree to it for the sake of his family, and he very shortly found himself in a spy-training school in Hamburg, where they taught him something about radio transmission—just a smattering —and, among other things, something about microphotography and codes and ciphers. The FBI found out about Sebold's schooling and met him here when he arrived with instructions to contact one Fritz Duquesne and Lilly Stein.

Duquesne was a man who came to this country from South Africa

to set up an anti-British propaganda system. He was an international character, known to the police of many countries and to the FBI. Lilly Stein was also an international figure. The FBI kept them under surveillance for about two years. This investigation unearthed a group of thirty-three men and women who were a part of the general espionage system. They had people who were used as couriers, men on ocean-going clippers, men in all walks of life. During the course of that investigation, it was necessary to get a lot of evidence, which consisted of motion pictures of their meetings with one another; also records and transcriptions of their conversations with each other. Beyond that, when the German government sent over a sum of money to their ring here for the erection of a radio station on Long Island, the money fell into our hands. A radio station was established by the FBI with FBI operators over a period of a year and three-quarters. Something over two hundred items of information, which had been requested by the German government, were sent. The only rub was that every item was censored by the Navy Department, the War Department, State Department, and finally by the FBI. But it worked for a year and three-quarters. A lot of false and misleading information was sent.

Early in 1939 the Army and Navy asked us to survey plants producing war material and to submit recommendations as to how the plants could be adequately protected against sabotage and espionage activity. The FBI surveyed over 2500 plants, and many of the refinements of plant protection that exist today in our war plants were due to FBI recommendations. The surveying agents concentrated on the vulnerable parts of the plants. We suggested that the plant guards be men with the qualifications of policemen and that they be properly trained and armed. The plant's methods of handling confidential documents and files were examined. The product that was being manufactured was given protective consideration. Identification badges for employees and proper supervision, while changing shifts, were points that were stressed. Fingerprinting of applicants for jobs in the plants was advocated. The Army took over this job of surveying plants, shortly after the war started. But the FBI is still responsible for war investigations that affect these private plants. The fact that a plant may have 100% contracts with the Army or Navy or both does not relieve the FBI of the responsibility of investigating sabotage and

espionage in the plant, nor does it relieve the plant officials of their responsibility immediately to notify the FBI of any sabotage in their plants.

On the night of December 7, 1941, after the Japanese attack upon Pearl Harbor, into every one of our fifty-six offices, teletypes were sent from Washington at nine o'clock, instructing us to pick up all dangerous enemy aliens—Japanese, Italian, and German. Now there might have been a lot of running around and confusion at that time, if adequate preparations had not been made. There was no such thing. Within half an hour, the project was in operation, and a large number of the three thousand that were picked up within thirty-six hours were taken to Immigration Stations, because for two and a half years the FBI had in their locked files and drawers the information on all of our enemies who were of alien birth. Those cards contained photographs, names, locations, business addresses, associates, and relatives, and evidence against them. At the present time, there are over thirteen thousand who have been apprehended in this country. All were turned over to the Immigration Stations. From there they went before the Alien Enemy Boards made up of prominent citizens. Those boards can recommend parole, release, or internment. Those recommendations then go to Washington to the Attorney General, and he can confirm them or have them put away for the rest of the war.

Every day since January 8, the FBI has been going into the homes of enemy aliens whom we believe might have contraband in their houses, because on January eight, the President asked all enemy aliens to turn over to their local police departments all contraband material, firearms, ammunition, explosives, short wave radio receivers, transmitters, and signaling devices. The FBI has been going into the homes of enemy aliens, where they have clustered around defense plants, defense installations, military and naval facilities, and searched for contraband material. Whenever they did have any of that contraband material, they were apprehended and brought before the United States Attorney, who decided whether the infraction of the law was serious enough to have that individual brought before the Alien Enemy Board and if so, the Alien Enemy Board would decide whether that person should be interned or released. In the period since January 1942, in one year's time, we have picked up over 7500 rifles, close to 13,000 pistols and

revolvers, tons of explosives and enough photographic equipment for a half dozen manufacturing establishments. We have found 154 Japanese in the three states of New Hampshire, Massachusetts, and Maine. They are mostly the Japanese who are of the servant type, domestic servants. On the West Coast, they have a different breed, the college man and the man in the business and professional class. We have close to 6,000 German enemy aliens. No enemy alien can move out of the community without receiving a permit at least seven days in advance from the United States Attorney in his district, a written permission, otherwise he is violating the President's regulations and is liable to internment. I can assure you of one thing. Even if there were an opportunity for these enemy aliens to rise among us and hurt us, they would not have the firearms or the explosives to do us a bit of harm.

Q. Has there been any attempt to sabotage water works plants? A. We have had a lot of complaints of Japanese being near installations. We have had a certain number of cases of trespassing, but when we have followed them up we have determined that the trespassing had nothing to do with any real depredations. We have gone out on a number of water works cases, particularly in Connecticut, and here too, but they have never been serious.

Q. Do we contact the FBI directly or through another channel? A. Contact directly as a private citizen. The President has asked that all private citizens bring all cases of sabotage and subversive activities directly to the attention of the FBI.

PROCEEDINGS

FEBRUARY 1943 MEETING

HOTEL STATLER, BOSTON, MASS.

Thursday, February 18, 1943

Vice-President Horace L. Clark in the chair.

Secretary Gifford announced the election of the following members:

Frank J. Thiery, Foreman, Water Department, Bristol, Conn.; and Richard P. Barstow, Superintendent, York Water District, York, Me.

Arthur C. King reported on bills pending before the Massachusetts Legislature.

Harold W. Hackett, of the American Board of Foreign Missions, gave a talk outlining experiences and conditions in Japan prior to and immediately following Pearl Harbor.

Professor A. G. Dietz, Department of Building Engineering and Construction, Massachusetts Institute of Technology, gave a talk on "Plastics in Water Works." Stuart E. Coburn, E. Sherman Chase and Robert Spurr Weston took part in the discussion.

A sound film in colors of South American places and people, entitled "Our Neighbors Down the Road," was then shown.

MARCH 1943 MEETING

HOTEL STATLER, BOSTON, MASS.

Thursday, March 18, 1943

Vice-President Horace L. Clark in the chair.

Secretary Gifford announced the election to membership of Chester E. Bradley, Superintendent, Water Department, Swampscott, Mass.

Richard H. Ellis offered the following motion, after discussion:

"That the specifications for cold water meters, displacement type,

as prepared by the joint committee of the American Water Works Association and the New England Water Works Association, and as published in the December 1942 JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, be accepted as tentative specifications for the New England Water Works Association; and, further, that the emergency alternate provisions, as published in the addendum to the above-referred to specifications, be adopted for the duration of the present national emergency."

The motion was duly seconded and carried.

Arthur C. King reported actions by the Massachusetts Legislature.

A paper, "New Trends in Ground Water Development," was read by Ross Nebolsine, Consultant, Ranney Water Collector Corporation of New York. Chairman Clark, Linn H. Enslow, Henry T. Gidley, and Francis H. Kingsbury took part in the discussion.

Arthur L. Shaw, after discussion, presented the following motion:

"That the New England Water Works Association record itself as not voting on specifications for threaded cast-iron pipe for drainage, vent and waste services as jointly proposed by ASA committees A-40 and A-21."

The motion was duly seconded and carried.

A paper, "Measures Taken at Falmouth, Massachusetts, to Control Red Water and Tuberculation of Mains," was read by E. Sherman Chase, Metcalf and Eddy, Consulting Engineers, Boston. The paper was discussed by Roger W. Esty.

Ernest J. Sullivan discussed the new rulings of the War Production Board.

ALLAN F. MCLARY. It seems that hardships have been imposed on the water utilities in the matter of inventory, and with a view of relieving some of this hardship this resolution is offered. It is addressed to J. A. Krug, Director, Office of War Utilities, War Production Board, Washington, D. C., and it reads as follows:

"WHEREAS the previous provisions of paragraph (f) (2) of water utilities order U-1, which limits the practical working minimum of inventory to four-thirds of the dollar value of items of the same class withdrawn from inventory during the last nine months of 1942, imposed a hardship on water utilities,

"WHEREAS this order penalized those utilities which tried to

cooperate with the War Production Board to the fullest extent and used as little material as possible during the last nine months of 1942,

"WHEREAS most water utilities, with the exception of those directly affected by the war effort made only absolutely essential replacements and postponed many border line projects,

"WHEREAS this postponed maintenance can not be held to the very low levels of 1942,

"WHEREAS the former limit of sixty per cent of the December 31, 1940 inventory has brought inventories below the safe working minimum in many instances,

"*Resolved* that the New England Water Works Association respectfully requests that the War Production Board amend this order so that water utilities may be allowed an inventory which will enable them to maintain a safe and adequate water supply at all times."

I offer the adoption of the resolution.

The motion was duly seconded and the resolution was adopted.

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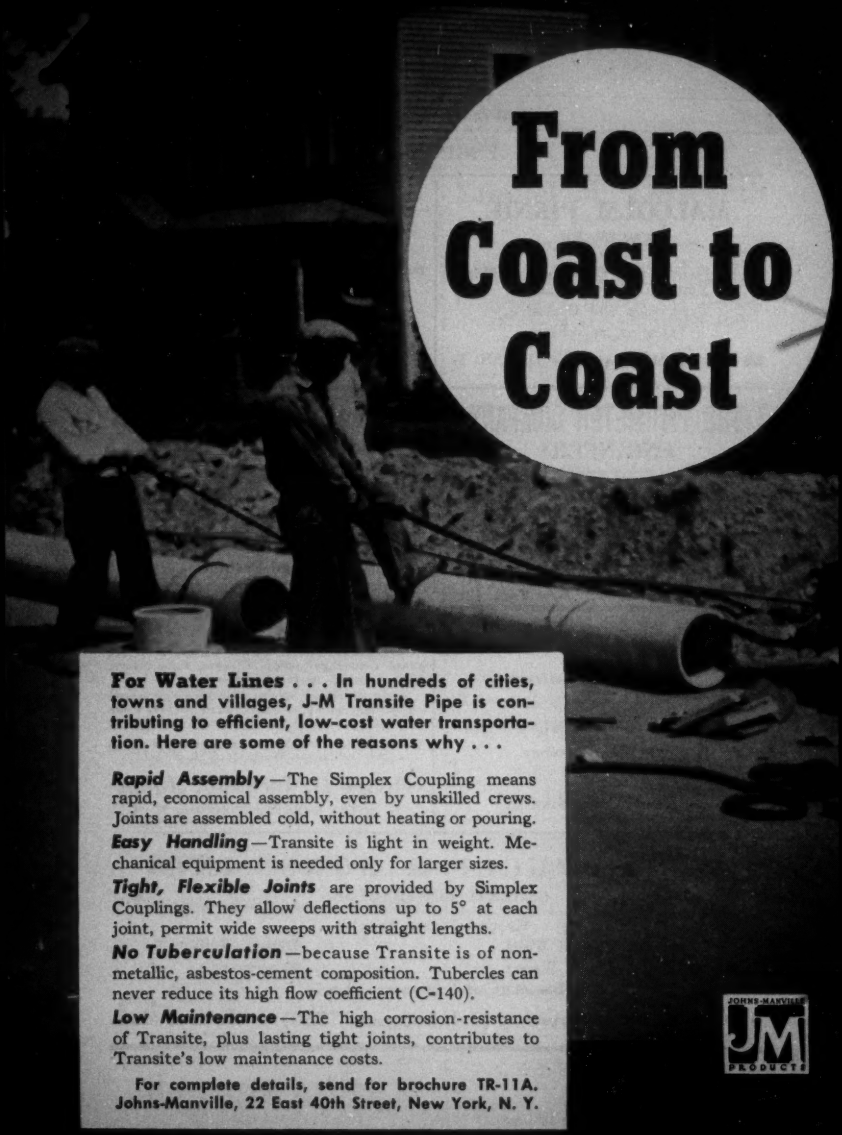

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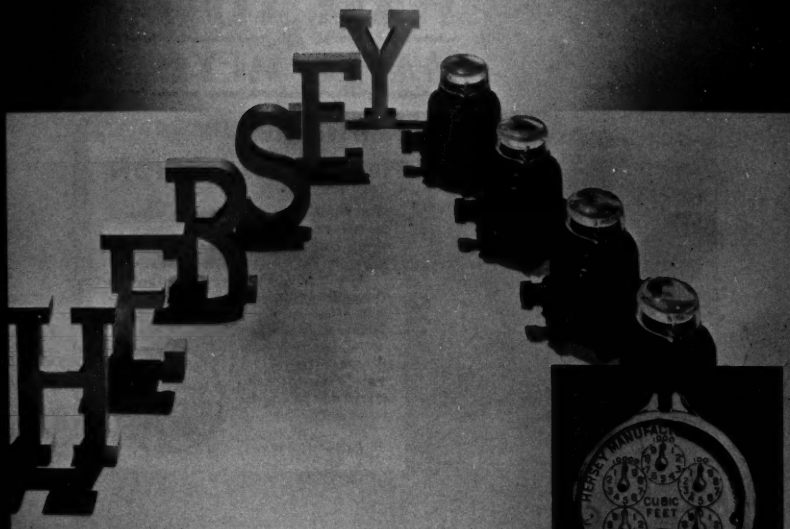

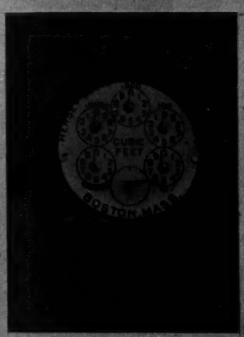

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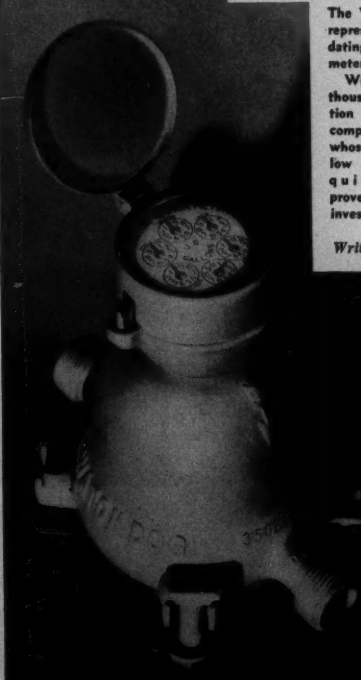

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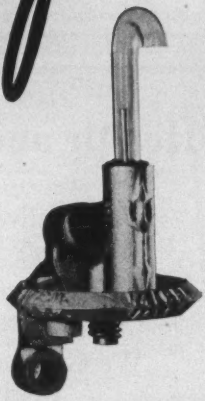

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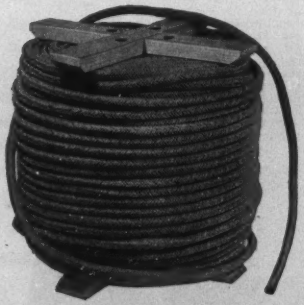

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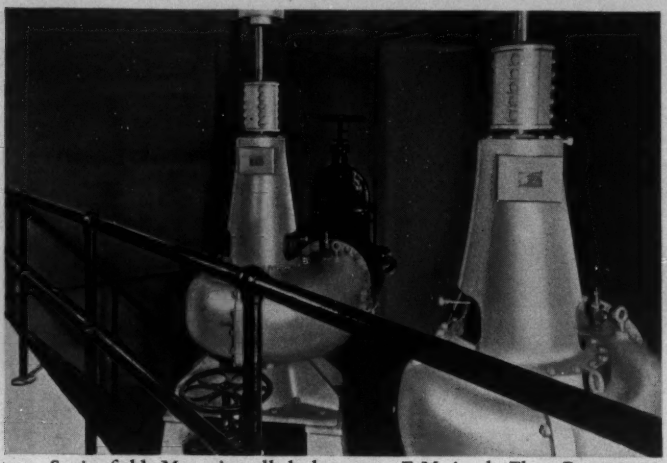

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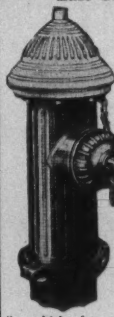

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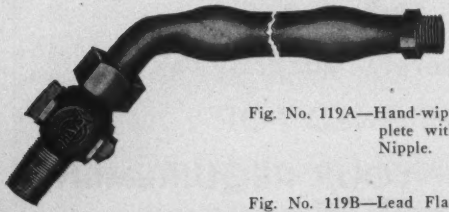
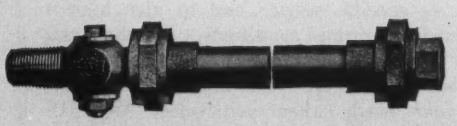


Fig. No. 119A—Hand-wiped Joint Lead Gooseneck complete with Corporation Stop and Male Nipple.

Fig. No. 119B—Lead Flange Gooseneck, complete with Corporation Stop and Lead Flange by Female Iron Pipe Union Coupling.



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When we have won the war, such equipment as shown above will again be available to New England Water Works.

As Engineers and Contractors we hope to have the pleasure of supplying your requirements, at that time, as we have been doing for the past thirty-seven years.

(This is the second of a series of typical installation advertisements.)

TURBINE EQUIPMENT COMPANY OF NEW ENGLAND

80 Federal Street **Phone LIBerty 5993-5994** **Boston, Mass.**

New England Representatives for

DE LAVAL STEAM TURBINE COMPANY

TRENTON, NEW JERSEY

WHEN THE TOWN IS "FULL UP..!"

HEALTH RECORDS HINGE ON

MORE EFFECTIVE *Chlorination*

America's wartime public health record is highly favorable, even in cities jam-packed with war workers. An important contributing factor has been the successful protection against water-borne disease, maintained in spite of overloaded water treatment facilities.

In many such cities, the need to stretch capacity of the water plant has put more responsibility than ever on *chlorination.* Even without the purchase of additional equipment, these plants have found it possible to use their W&T Chlorinators more effectively to reduce the filter load and to supply safe water at rates above the normal treatment capacity of the plant.

In other cases, W&T Emergency Chlorinators have provided the fastest, most direct way to cut in temporary supply sources without sacrificing safety.

If there's a chance that your water system is likely to face this problem—check now with your W&T Representative as to ways and means of using chlorination to see you through. SA-148-S

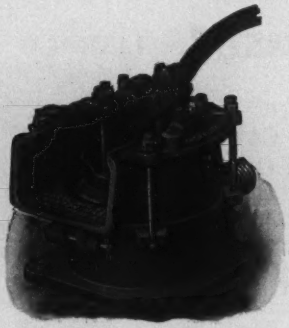
"The Only Safe Water is a Sterilized Water"

WALLACE & TIERNAN CO., INC.

MANUFACTURERS OF CHLORINE AND AMMONIA CONTROL APPARATUS

NEWARK, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

EDSON
PUMPS and ACCESSORIES



Hand Pumps – Power Pumps
Truck or Trailer Mounted
Edson Special Suction Hose
Red Seal Diaphragms
Edson Bronze Hydrant Pump
Strainers, Adapters, etc.

Distributors for
Pollard Pipe Line Equipment
Electric Pipe Thawers

Universal Pipe Locator
Universal Water Leak Detector

THE EDSON CORPORATION
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New York: 142 Ashland Place, Brooklyn

Warren Foundry & Pipe Corp.
ALSO
Warren Pipe Co. of Mass., Inc.

SALES OFFICES
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75 FEDERAL STREET, BOSTON, MASS.

Manufacturers of

CAST IRON PIPE

Flanged Pipe *Flexible Joint Pipe*
Bell and Spigot Pipe
Special Castings *Short Body B. & S. Specials*
Warren (WF) *Spun Centrifugally Cast Iron Pipe*

WORKS: PHILLIPSBURG, N. J. and EVERETT, MASS.

Large Stock Enables Us to Make Prompt Shipments

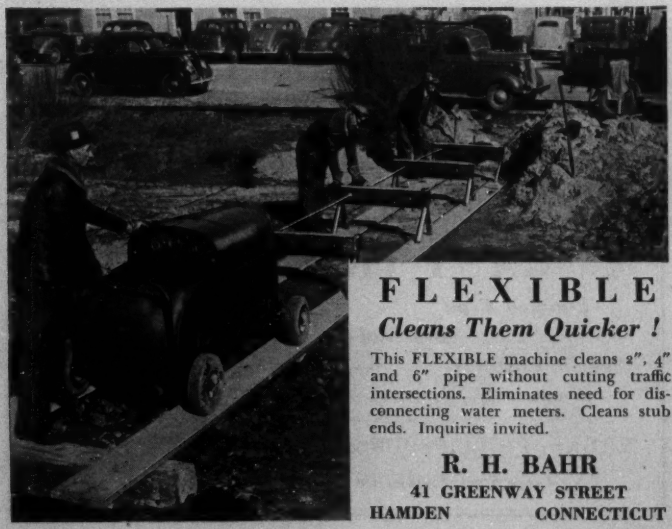
For an Extremely Smooth Pipe Interior
SPECIFY

SPUN **BITUMASTIC** LINING
REG. U.S. PAT. OFF.

This Will Assure You of
NO LOSS IN CAPACITY
NO TUBERCULATION OR INCRUSTATION
NO EFFECT ON WATER QUALITY

Recent Repeat Flow Test Shows High Williams Hazen Coefficient Unchanged After EIGHT YEARS

Wailes Dove-Hermiston Corporation
General Offices: Westfield, N. J.
New York District Office: 17 Battery Place, N. Y. C.



FLEXIBLE
Cleans Them Quicker !

This FLEXIBLE machine cleans 2", 4" and 6" pipe without cutting traffic intersections. Eliminates need for disconnecting water meters. Cleans stub ends. Inquiries invited.

R. H. BAHR
41 GREENWAY STREET
HAMDEN CONNECTICUT

1879—ROSS— 1879

AUTOMATIC VALVES

Controls elevation of water in tanks, basins and reservoirs

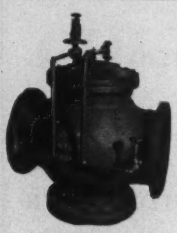
ALTITUDE VALVE

1. Single Acting
2. Double Acting

A self contained unit, with three or more automatic controls

COMBINATION VALVE

Combination automatic control both directions through the valve.

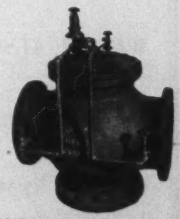


Maintains desired discharge pressure regardless of change in rate of flow

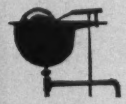
REDUCING VALVE

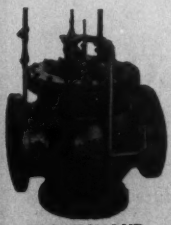
Regulates pressures in gravity and pump systems; between reservoirs and zones of different pressures, etc.

Maintains safe operating pressures for conduits, distribution and pump discharge



SURGE-RELIEF VALVE





Maintains levels in tank, reservoir or basin

1. As direct acting

2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

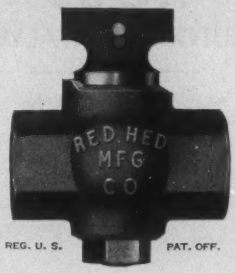
FLOAT VALVE

Electric remote control—solenoid or motor can be furnished

REMOTE CONTROL VALVE

Adapted for use as primary or secondary control on any of the hydraulically controlled or operated valves.

ROSS VALVE MFG. CO., INC. Box 592 TROY, N. Y.



THE ARMED FORCES MUST BE SERVED!

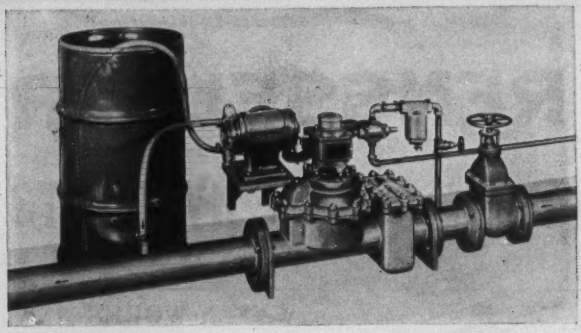
WE ARE ALSO USING EVERY REASONABLE EFFORT TO FURNISH RED HED BRASS GOODS FOR WATER WORKS EMERGENCY AND REPAIR REQUIREMENTS.

RED HED MFG. CO.

Manufacturers of

RED HED Brass Goods for Water Works

368 Congress Street Boston, Mass.



CHEM-O-FEEDER

AUTOMATIC & PROPORTIONAL

PROTECTING AMERICA'S FIGHTING MEN & CIVILIANS FROM WATER-BORNE DISEASE

DESCRIPTION: Automatic & Proportional Chem-O-Feeders (double diaphragm type) feed hypochlorite solution in proportion to variable flow in gravity or pumped water systems. This hydraulically operated %Proportioneer% starts, stops and varies feeding rate in step with flow through any standard mechanical water meter . . . of disc, turbine, propeller or other type. Sold with or without meter — previously installed meter can be employed if desired. Accurate registration (A.W.W.A. Standard) is not affected as the standard model, powered by pressure in the main (10 to 100 lbs. per sq. in.) is only *paced* . . not driven . . by the meter. Dosage is easily adjustable, feeding 100% ± 2% proportional throughout range of meter. More than one Chem-O-Feeder can be controlled from a single meter, facilitating the handling of two or more chemicals. The Chem-O-Feeder may be located at convenient working level away from meter and pilot valve control. Waste water minimized not to exceed 5 times volume of chemical solution pumped daily. Patented annular bead, fabric reinforced, reagent diaphragm construction - - no springs used to actuate return stroke, no extra piping for balancing water pressure.

USES: In addition to chlorination of variable flow water systems, Automatic & Proportional Chem-O-Feeder is used to feed:

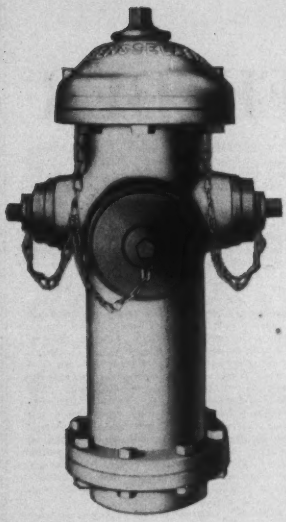
Alum	Sodium Aluminate
Soda Ash	Caustic
Ferrous Sulphate	Ferric Chloride
Ferric Sulphate	Sulphuric Acid
Calgon	Aqua Ammonia
Lime Slurry	Aluminum Sulphate, etc.

% PROPORTIONEERS, INC. %

63 CODDING ST., PROVIDENCE, R. I.

RENSSELAER

Defender FIRE HYDRANTS



WATER WORKS MEN:

Are your service crews cut to the minimum due to the war? If so, we know you are doubly thankful that your RENSSELAER* hydrants can be completely serviced by ONE MAN.

*These were formerly known as "COREY" hydrants.

★

American Water Works Association Standard Specifications

★

Rensselaer Valve Co. TROY, NEW YORK

NEW ENGLAND BRANCH COOMBS BLDG., HAVERHILL, MASS.

Mr. Herbert H. Crowell, Sales Manager

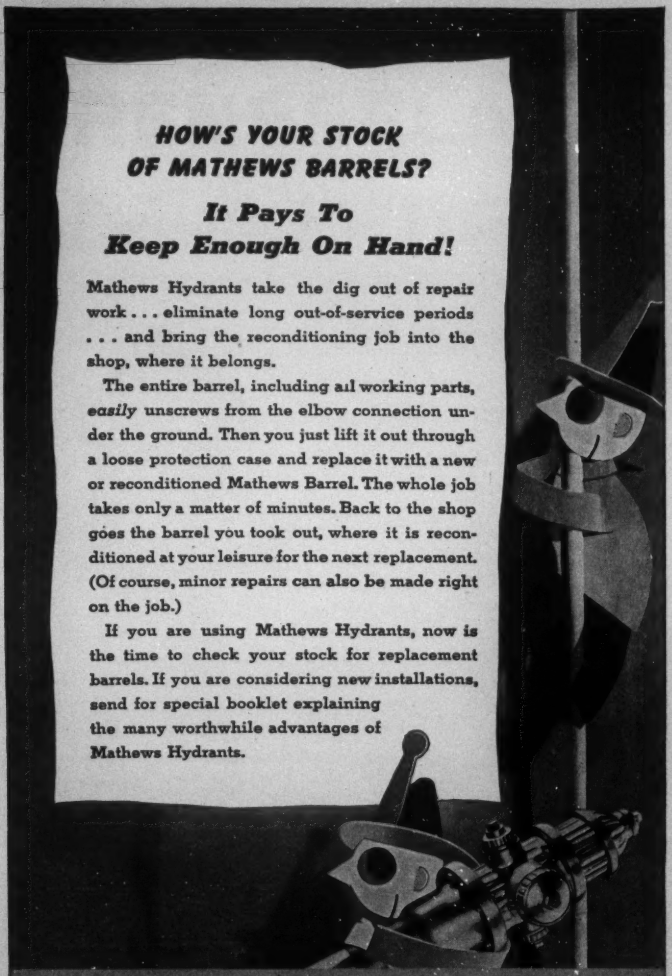
HOW'S YOUR STOCK OF MATHEWS BARRELS?

It Pays To Keep Enough On Hand!

Mathews Hydrants take the dig out of repair work . . . eliminate long out-of-service periods . . . and bring the reconditioning job into the shop, where it belongs.

The entire barrel, including all working parts, *easily* unscrews from the elbow connection under the ground. Then you just lift it out through a loose protection case and replace it with a new or reconditioned Mathews Barrel. The whole job takes only a matter of minutes. Back to the shop goes the barrel you took out, where it is reconditioned at your leisure for the next replacement. (Of course, minor repairs can also be made right on the job.)

If you are using Mathews Hydrants, now is the time to check your stock for replacement barrels. If you are considering new installations, send for special booklet explaining the many worthwhile advantages of Mathews Hydrants.



MATHEWS HYDRANTS

400 CHESTNUT STREET, PHILADELPHIA, PA.

ESTABLISHED IN 1808

Made by R. D. WOOD Company

MANUFACTURERS OF SAND SPUN PIPE (CENTRIFUGALLY CAST IN SAND MOLDS) AND R. D. WOOD GATE VALVES

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WROUGHT IRON PIPE. (See Pipe, Wrought Iron and Steel.)

When the Whistles Blow at War's END . . . will your Plans for Improvements be ready?

Preparedness for peace—complete, detailed plans for war-deferred water supply, gas and sewage works construction — is a practical and patriotic contribution to the Nation's post-war welfare.

* * *

War demands have made it impossible to carry on normal improvements and extension to these vital services. In some instances where construction could not be deferred, materials have been used which would not ordinarily be considered for permanent construction. Authorities estimate that more than a billion dollars of such improvements, extensions and replacements, necessary to public health and safety, has been deferred.

* * *

This reservoir of accumulated public works represents millions of man-hours of employment for returning soldiers and jobless war workers.

* * *

The time to prepare working plans and specifications for improvements, for extensions, and for replacement of temporary construction with permanent materials, is NOW, when engineering departments and consulting engineers are not rushed with work. Plans in readiness will save months of delay at a time when the transition from wartime to peacetime economy will be the Nation's number-one problem.

* * *

Any of the members of this Association will furnish prompt information and advice in the preparation of specifications taking full advantage of the greater economy and efficiency of cast iron pipe made in accordance with the new A. S. A. Law of Design* — pipe scientifically designed for your specific service requirements.

* Developed under the auspices of the American Standards Association in cooperation with the American Gas Association, American Water Works Association, New England Water Works Association, American Society for Testing Materials and the members of Cast Iron Pipe Research Association.

CAST IRON PIPE

Pipe founders plus

You may know us as America's largest producer of cast iron pipe but not be aware that we have exceptional facilities to cast and completely machine special castings in accordance with engineers' designs and specifications. Many of them, now—machine tool, marine engine and dry dock castings—are being made for the furtherance of the war effort. Our special castings foundries, and a specialized plant for the manufacture of fittings, are equipped to meet unusual industrial requirements, particularly in the process industries, as well as in the water supply, gas and sewerage fields. Our technical and laboratory staffs are experienced and resourceful. We invite you to take up with us any problems you may have in connection with the design of pipe, fittings or special castings for present or post-war requirements.

A special castings foundry at one of our plants, drawn by Hugh Ferris.

UNITED STATES PIPE & FOUNDRY CO.

General Offices: Burlington, N. J. *Plants and Sales Offices Throughout the U. S. A.*

The Journal of the New England Water Works Association

is a quarterly publication, containing the papers read at the meetings, together with reports of the discussions. Many of the contributions are from writers of the highest standing in their profession. It affords a convenient medium for the interchange of information and experience between the members, who are so widely separated as to find frequent meetings an impossibility. Its success has more than met the expectation of its projectors; there is a large and increasing demand for its issues, and every addition to its subscription list is a material aid in extending its field of usefulness.

All members of the Association receive the JOURNAL for two dollars per annum which sum is included in their annual dues; to all others the subscription is four dollars per annum.

TO ADVERTISERS

THE attention of parties dealing in goods used by Water Departments is called the JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION as an advertising medium.

Its subscribers include the principal WATER WORKS ENGINEERS and CONTRACTORS in the United States. The paid circulation is **1000** COPIES.

Being filled with original matter of the greatest interest to Water Works officials it is PRESERVED and constantly REFERRED TO BY THEM, and advertisers are thus more certain to REACH BUYERS than by any other means.

The JOURNAL is not published as a means of revenue, advertisements being inserted solely to help meet the large expense of publication.

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Size of page, 4½ x 7½ net.

A sample copy will be sent on application.

For further information, address the Advertising Agent,

MISS MILDRED LIGHTBODY,
613 STATLER BUILDING,
BOSTON, MASS.

LEADITE

COSTS ARE REDUCED WHEN *LEADITE* IS USED

Of course, the greatest advantage in using LEADITE, is, that it makes a good, tight joint,—and thus reduces leakage to a minimum,—but LEADITE also offers the following advantages, which are worthy of serious consideration: Saves caulking expenses—Reduces cost of digging large bell-holes —Saves in cost of material—Reduces time required for pumping "wet trenches"—Saves time in preparation—Saves time in handling on the job—Saves in freight and hauling charges.

Another point, LEADITE saves "interest charges" by speeding up the completion of the water line.

The true value of LEADITE is best indicated by the fact that it has been used on THOUSANDS OF MILES of Water Mains,—all over this Country, as well as in many Overseas Countries.

The Pioneer self-caulking material for c. i. pipe,
Tested and used for over 40 years,
Saves at least 75%.

THE LEADITE COMPANY

Girard Trust Company Building — Philadelphia, Penna.